Read Five Nobelists in Science

CHEMISTRY

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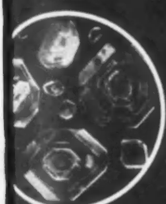

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Atoms Do Move

➤ THOSE WHO have trouble seeing a cloud of bustling atoms when they look at the hard surface and sharp corners of a desk may find comfort in the methods of chromatography, subject for which one set of this year's Nobel prizes became the reward. They may, on the other hand, be still further confused by the atomic properties studied by the other set of Nobelists.

A way of tuning in by radio frequency on the heart or nucleus of the atom to determine the mysterious and strange forces within it won for two American physicists the 1952 Nobel prize for physics. Nuclear properties of the atom are keys to future atomic progress.

Independent work along the same lines was done by Dr. Felix Bloch, Stanford University professor of physics, and Dr. Edward M. Purcell, Harvard University professor of physics, who share the prize worth about $33,000.

Atomic particles spin and carry electric currents. They thus behave like small magnets. Placing these invisible magnets in an alternating magnetic field gives rise to electric forces which can be measured by short radio waves. New information about the structure of matter has been discovered by varying the electric and magnetic forces to which atomic magnets respond, and measuring the time necessary for their response.

One application of the method by Dr. Purcell was the prediction of invisible hydrogen gas in the space between the stars of the Milky Way and the detection of its radiation with a radio telescope.

Chromatography, the process developed by British biochemists, Dr. Richard L. Millington Synge and Dr. Archer J. Porter Martin, this year's Nobelists in chemistry, is fundamentally as simple as blotting ink or mopping up spilled milk. The fibers take up the liquid, as everyone knows. Only the scientist stops to ask how this happens and where the liquid goes.

The principle was used by the Russian botanist, Michael Tswett, in 1904, to learn the constitution of the green coloring matter of grass and leaves. Newer adaptations of the method are used for many colorless substances, but the name chromatography has stuck with the process.

Drs. Synge and Martin adapted chromatography and extended it to produce new information about albumin and other life substances.

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Editors: WATSON DAVIS and HELEN MILES DAVIS

Consulting Editor: PAULINE BEERY MACK (Editor 1927-1944)

—Photo by Fremont Davis

▶ GERMS *are prevented from growing in the culture medium in the petri dish by the antibiotic streaked across. This historic photograph of Dr. Selman A. Waksman was taken in 1940, at a meeting of the National Academy of Sciences. Three years later he crowned his researches on soil organisms, which had been in progress at Rutgers University since 1915, by isolation of streptomycin, the antibiotic which successfully attacks the tubercle bacillus. For this work Dr. Waksman receives this year's Nobel prize in medicine.*

Five Nobelists in Science

▶ NOBEL PRIZES for 1952 have been awarded. The prize in medicine goes to Dr. Selman A. Waksman, of Rutgers University, New Brunswick, N.J. It was given for his long researches on antibiotics, culminating in streptomycin, the first effective antibiotic against tuberculosis. An article by Dr. Waksman describing antibiotics will be found on page 14 of this issue of CHEMISTRY.

The physics prize is divided between Dr. Edward M. Purcell of Harvard University, Cambridge, Mass., and Dr. Felix Bloch of Stanford University, Stanford, Cal. These two scientists, on opposite sides of the continent, independently devised a method of measuring the resonating forces in atomic nuclei. The method reverses an experiment originally devised by Dr. I. I. Rabi of Columbia University, New York.

Dr. Rabi's experiment used the resonances of lithium chloride to determine and measure the magnetic prop-

erties associated with the spin of the atom. His account of how he did it is reprinted in this issue on page 12.

Dr. Purcell and Dr. Bloch each used information which had come from Rabi's method to turn the experiment around. The magnetic effects being known in general, they substituted a variety of materials for lithium chloride and determined the differences in results that could be attributed to the structures of the different atoms employed.

Dr. Purcell's original report of his work is reprinted in this issue on page 10. An article by Dr. Bloch describing his results, as reported to the National Academy of Sciences, begins on page 5.

Joint work which converted chromatography from a hit-or-miss art to a science with a manageable theory brought the Nobel prize in chemistry to Drs. Archer J. P. Martin and R. L. Millington Synge. They were working together at the Wool Industries Research Association, Torridon, Headingley, Leeds, England, when they wrote the paper on theory of chromatography which is the basis of their award. Extracts from that paper are quoted in this issue beginning on page 3.

Dr. Martin is now at the National Institute for Medical Research in London. Dr. Synge is at the Rowett Research Institute in Aberdeenshire, Scotland. Although their early work, from which the theory of the proportions, concentrations and rates of travel in chromatography was worked out used the conventional column, the British chemists are equally famous for their development of the techniques of paper chromatography.

This simplified method by which chemical substances, aided by suitable solvents and elutants, sort themselves out onto different areas of a sheet of filter paper, is widely used. It has solved such problems as the separation and identification of amino acids, on which its discoverers worked. It is invaluable in work with radioactive tracers.

In the most modern form of paper chromatography, a solution is induced to streak its way across one side of a sheet of filter paper until the components are well spread out. The sheet of paper is then turned through 90°, so that the side where the streak was made becomes the bottom (or, in another technique, the top) from which a new solvent starts. The spread-out components travel in a new direction, at right-angles to the first path.

After a time, each component is found at a different spot on the surface of the paper. It is an easy matter to run a Geiger counter or other detecting device over the surface and find the chemical that contains the radioactive atoms. A simple clip of the scissors separates the desired chemical from the other components of the original solution. It may then be brought into solution for further study, or even tested while still on the filter paper.

* * *

Chromatography

A New Form of Chromatogram Employing Two Liquid Phases. 1. A Theory of Chromatography. 2. Application to the Micro-Determination of Higher Monoamino-acids in Proteins. By A. J. P. Martin and R. L. M. Synge. The Biochemical Journal, 35:12 (1941). (Extracts from this paper are reprinted here.)

➤ IN MOST forms of counter-current extraction column the very small drop required for the rapid attainment of equilibrium, and hence for high efficiencies, cannot be used owing to the difficulty of preventing it moving in the wrong direction. In the case of a solid, however, for any reasonable size of particle a filter will prevent movement in any desired direction. Consideration of such facts led us to try absorbing water in silica gel, etc., and then using the water-saturated solid as one phase of a chromatogram, the other being some fluid immiscible with water, the silica acting merely as mechanical support. Separations in a chromatogram of this type thus depend upon differences in the partition between two liquid phases of the substances to be separated, and not, as in all previously described chromatograms, on differences in adsorption between liquid and solid phases.

Theory of Chromatography

The chromatogram has for a long time been realized to be closely analogous in its mode of operation to distillation and extraction fractionating columns. No one, however, seems to have attempted to work out in detail the theory of the chromatogram using the concepts developed for distillation.

—British Information Services photo.

➤ LABORATORY TECHNIQUES *used in chromatography are displayed by Dr. Archer J. P. Martin, British chemist who shares the 1952 Nobel prize in Chemistry with Dr. R. L. Millington Synge.*

This we attempt to do here, and thus to give a picture of the concentration of solute at any time and place in the column, and of the way in which the resolution depends upon the length of the column.

Factors Influencing H.E.T.P.*

The height equivalent to a theoretical plate depends upon the factors controlling diffusion and upon the rate of flow in any given case, since diffusion from plate to plate becomes relatively more important the slower the flow of

* H.E.T.P. = height of the equivalent theoretical plate. Peters, 1922. Cf. Sherwood, 1937.

—British Information Services photo.

➤ LONG STRIPS *of filter paper separate chemicals in the process of chromatography. Dr. R. L. Millington Synge shows how the strips are handled in his laboratory in Scotland. He shares this year's Nobel prize in Chemistry with Dr. Archer J. P. Martin.*

liquid and tends of course always to increase the H.E.T.P. Apart from this, the H.E.T.P. is proportional to the rate of flow of liquid and to the square of the particle diameter. Thus the smallest H.E.T.P. should be obtainable by using very small particles and a high pressure difference across the length of the column. The H.E.T.P. depends also on the diffusibility of the solute in the solvent employed, and in the case of large molecules, such as proteins, this will result in serious decrease in efficiency as compared with solutes of molecular weights of the order of hundreds.

Practical Limitations

The separations obtainable in practice are less than the theory predicts for two principal reasons. First, the partition coefficient is seldom a constant, usually decreasing as the solution becomes stronger. This results in the front of the band becoming steeper, and the back flatter and, more importantly, in the band becoming wider, since the concentrated part moves faster than the dilute part. This effect can sometimes be diminished by working with initially dilute solutions.

Interaction between two solutes often, however, leads to an increase in separation over the theoretical, the more strongly absorbed solute "eluting" the less strongly absorbed, and thus tending to cause a sharp boundary between the two, reminiscent of the behavior of ions in the moving boundary in transport number determinations.

The other great source of loss of efficiency lies in lack of uniformity of flow through the column. This lack of uniformity often prevents good separations being realized even though the solutes be separated in the column itself, as the cut cannot follow the required surface. In striving for conditions for uniformity of flow, the high pressure and small particle size desirable for smallest H.E.T.P. have to be abandoned.

Summary

1. A new form of chromatogram is described, depending not on adsorption on a liquid phase, but on partition of solutes between two liquid phases.

2. Visual detection of colorless acids in this chromatogram can be achieved by adding an indicator to one of the phases.

3. A general theory of chromatography applicable to substances with linear distribution isotherms is developed. This theory is based on the "theoretical plate" concept, thus directly relating chromatography to fractional distillation and extraction.

4. The theory is checked experimentally in the new chromatogram.

5. The new chromatogram is applied to the micro-determination of the higher monoamino-acids in protein hydrolysates.

On the Back Cover

➤ CHROMATOGRAPHY *looks like this. At the National Bureau of Standards, the sugar research laboratory uses chromatographic methods to distinguish sugars and related compounds. Photo by Fremont Davis.*

—Stanford University photo.

➤ ATOMIC NUCLEI *act like tiny radio transmitters in the method devised by Dr. Felix Bloch for determining the properties of these mysterious hearts of matter. Dr. Bloch of Stanford University shares the 1952 Nobel prize in Physics with Dr. Edward M. Purcell of Harvard. Independently they worked out the same process for getting information from the atom.*

Magnetic Forces in the Nucleus

Nuclear Induction, by Felix Bloch. Physics Today, August 1950.

➤ IT IS NOW somewhat over four years since the phenomenon was discovered which is alternately known as "nuclear magnetic resonance absorption" or "nuclear induction." In the meantime it has become so widely known among physicists that it seems hardly necessary any more to explain it. Nevertheless, for the benefit of those who have not followed closely the developments we shall start with a brief recapitulation of the basic principles.

As the shortest general description of the phenomenon one can say that it consists of the electromagnetic effects accompanying the reorientation of nu-

clear moments. To achieve a substantial reorientation, one makes use of the principle of "magnetic resonance," first used successfully at Columbia University in the research on molecular beams, where an alternating magnetic field is applied at right angles to a constant field with its frequency equal to the Larmor frequency of precession of the nuclei in the constant field. The frequencies thus required are at normal conditions in the range of short radio waves. The essential difference lies in the detection of nuclear reorientation which is not achieved here by observing a different path of the molecules as in the work with molecular beams, but by the effects upon suitably designed radio-frequency circuits. These effects can be interpreted and observed in many different ways. One can speak about absorption or dispersion, one can observe the regeneration or the frequency change of an oscillating circuit, one can utilize the reaction upon the system which provides the alternating field or use a separate receiver system for observation. In any case, the effects can be traced back to the induced electromotive force which has been known, since the days of Faraday, to accompany a change of the magnetic induction, and which is here due to the change in orientation of nuclear magnetic moments. It is for this reason that the term "nuclear induction" seems most suitable and descriptive of the phenomenon as a whole, and it shall be used in this general sense.

With this understanding it can be stated that research on nuclear induction has progressed in various directions and in many laboratories, in this country, notably at Harvard, MIT, Rutgers University, Brookhaven, the Bureau of Standards, Ohio and Illinois State Universities, Chicago, St. Louis, and Stanford. Progress has been in the direction of higher sensitivity, greater accuracy, and a wider range of applications. This account will be restricted to a few special topics, not because others are considered of less importance but merely because of limited space and the fact that the author has recently been most concerned with these selected topics.

We shall start with the problem of measuring with high precision the magnetic moments of different nuclei. It is based upon the fact that the (circular) Larmor frequency of precession, and hence the resonant frequency, of the alternating field is given by the product of the "gyromagnetic ratio" of the nucleus under investigation and the magnitude of the applied constant magnetic field. The gyromagnetic ratio is equal to the ratio of the magnetic moment and the angular momentum of the nucleus; measured in units of Planck's constant, divided by 2π, the latter is called the spin of the nucleus and is always a multiple of $\frac{1}{2}$.

There are several different methods of ascertaining the spin; once it is known, the problem of measuring the magnetic moment is equivalent to that of measuring the gyromagnetic ratio. The most accurate determinations of nuclear moments are relative: nuclei whose moments are to be determined are placed in the same sample and thus in the same field as certain "standard" nuclei of comparison; their gyromagnetic ratio is then equal to that of the standard, multiplied by the ratio of the corresponding resonance frequencies. The value of the constant field does not enter at all into such a

comparison and the relative accuracy is given by that with which either of the two frequencies can be measured, i.e., by the number of cycles which take place during a coherent observation.

In molecular beams this number is limited by the time which a molecule spends in traversing the apparatus and is, under favorable conditions, of the order of ten thousand. In observations of nuclear induction, the nuclei do not leave the recording apparatus; the coherence of observation is, however, interrupted by irregular interaction processes of the moments with the atoms and molecules in their neighborhood. The average time between such processes, or relaxation time, can sometimes be found to comprise the order of a hundred thousand cycles and thus offers the possibility of a corresponding accuracy. Relative accuracies of this order are of particular interest for the isotopes of hydrogen and have actually been obtained.

By a series of relative measurements the nuclear magnetic moments can all be expressed in terms of an ultimate standard, and the proton has been found to be most suitable for this purpose. The problem arises then of measuring the magnetic moment of this standard, which is of considerable interest itself as belonging to one of the two nuclear constituents. During the last twenty years the proton moment has been repeatedly measured by different methods and with increasing accuracy. Depending upon the method, the result is found in units of different fundamental constants, so that new relations can be established between these constants. Just during the last year several new methods have been applied, all leading to results with an accuracy of approximately one part in ten thousand.

Of these methods we shall particularly mention one which gives the proton moment in terms of the nuclear magneton, the natural unit of nuclear physics and defined as the Bohr magneton multiplied by the mass ratio of electron to proton. It was first applied over ten years ago in a rather crude calibration of the magnetic moment of the neutron and is based upon the cyclotron motion of protons. To be more specific, consider the frequency of a proton as it moves around a circle in a homogeneous magnetic field and, in the same field, the Larmor frequency of precession of a nuclear moment, belonging to a nucleus with spin $\frac{1}{2}$, such as a neutron or a proton. It can be shown that the two frequencies are to each other in the same proportion as the nuclear magneton to the magnetic moment of the nucleus. The value of the latter in nuclear magnetons is thus again obtained by the measurement of a frequency ratio with similar limitations on accuracy to those mentioned above. For protons, the Larmor frequency is obtained by observing through nuclear induction the resonance frequency in a sample of water; the frequency of orbital motion can be obtained by observing the accelerating or decelerating cyclotron action of an electric field in a small region, and either of the two actions has been utilized with similar accuracy to obtain the magnetic moment of the proton.

Another recent development is the application of nuclear induction to a great variety of nuclei, with the result that the more accurate knowledge of

the values of most magnetic moments is now due to this method. The nuclei are studied in solid, liquid, or gaseous samples or in compounds dissolved in a liquid. The choice of the sample is determined by considerations of density, chemical nature, and relaxation time. It is characteristic of the considerable gain in sensitivity over the earlier work that observations can be carried out on isotopes of low abundance and with relatively small moments and that gases without excessive pressure can be used.

It must be mentioned here that proper use of the method allows not only determining the gyromagnetic ratio of a nucleus but also, separately, the spin and the sign of the magnetic moment. The sign of a magnetic moment refers to its orientation relative to the angular momentum and the convention has been accepted of speaking about positive or negative moments in cases where this relative orientation is the same as that which exists for a rotating mass point with positive or negative electric charge, respectively; in this sense the proton has a positive, the neutron a negative moment. If the alternating field originates from currents flowing in a coil and the induced electromotive force is observed in another coil with the axes of the two coils perpendicular to each other and to the constant field, one can show that the sign of the magnetic moment is manifested by the phase relation of the voltage in the two coils. By superposition of the two voltages and subsequent rectification it is directly related to the sign of the observed rectified voltage. There is a third piece of information to be obtained from nuclear induction, i.e., the relative magnitude of the observed induced voltages. With a known density of nuclei, this makes it possible from the resonance frequency, the sign, and the magnitude of the observed signal voltages to infer not only the gyromagnetic ratio and the sign, but also separately the spin, and hence the magnitude of the nuclear magnetic moment.

While only the moments of the few very lightest nuclei can be directly interpreted in terms of nuclear forces and are therefore probably of the greatest fundamental significance, those of the heavier nuclei are nevertheless also of considerable interest. Their values have given considerable support to the hypothesis of nuclear shell structures; more supporting evidence has recently been obtained from nuclear induction. In this context it is sufficient, at present, to obtain data with a relative accuracy of a few per cent; the considerably higher accuracy which nuclear induction can furnish is however significant in isotopes of the same element. This is particularly true in view of the fact that corresponding data concerning the hyperfine structure can frequently be obtained with comparable accuracy from the magnetic resonance observed in atomic beams. It was originally thought that the ratio of hyperfine structure separations could be uniquely interpreted in terms of the ratio of the magnetic moments pertaining to isotopes. When both are measured independently and with high accuracy, there appear, however, small discrepancies, and they often allow most interesting conclusions concerning the effect of the specific nuclear structure upon the interaction with atomic electrons.

In measuring the magnetic moment

of nuclei with spin $\frac{1}{2}$ one has a considerable freedom in the choice of samples. Since liquids lead usually to sharper lines than solids, it is often advantageous to use solutions. To insure sufficient concentration the compound is here chosen primarily with regard to high solubility. It is sometimes more difficult to find the proper compound for the element under investigation if one deals with nuclei of higher spin. In this case there exists the possibility that the nucleus, besides its magnetic dipole moment, possesses also an electric quadrupole moment, and the inhomogeneous electric fields originating from the molecular surrounding may therefore cause an excessive broadening of the resonance line. To prevent this feature and the ensuing difficulty in observing nuclear induction, one must choose a compound where the symmetry of the molecule results in an effective cancelation of the broadening electric field gradients at the location of the nucleus under investigation.

It has recently been found that the choice of the compound can have an effect not only upon the width of the resonance but also upon the frequency at which it occurs. Identical nuclei, observed in the same external field, can lead to different frequencies if they are contained in different molecules, and the corresponding lines can be separated by an interval, well exceeding their width. Thus an aqueous solution of ammonium nitrate leads to two sharp nuclear induction signals from nitrogen, separated in frequency by about one part in two thousand, of which one can be ascribed to the positive ion of NH_4, the other to the negative ion of NO_3. This phenomenon is not connected with the existence of nuclear electric quadrupoles, since it can occur for nuclei of spin $\frac{1}{2}$ as well as for those of higher spin: it must be ascribed to the fact that the magnetic field which causes the precession of the moment is not exactly equal to the external field but that its value is modified by electrons in the neighborhood of the nucleus. It has been understood for a considerable time that the mechanism which leads to the diamagnetic susceptiblity of a substance would, at the same time, result in a slight shielding of the external field by the atomic electrons at the location of the nucleus. Considering, however, that only the outermost electrons are affected by the chemical binding, the observed effects are too large to be explained by a difference of diamagnetic shielding in different compounds. In certain compounds of cobalt, the effect can exceed one percent, and while this is quite an anomalous case, it indicates that more detailed considerations of molecular structure will be required to explain the observed chemical effects. They determine at present the limiting accuracy in our knowledge of many nuclear moments, since resonance frequencies are often more accurately known than the influence of the external electrons upon the effective value of the magnetic field. Experiments have shown, however, that this limitation does not apply to determinations of the ratio of moments when carried out for isotopes of the same element.

The influence of the chemical binding upon resonance frequencies rerequires further systematic studies. It may be hoped that they will remove

the present uncertainties and contribute to the understanding of this small but interesting effect which has been revealed through the great precision with which measurements of nuclear induction can be carried out.

Resonance Absorption

Resonance Absorption by Nuclear Magnetic Moments in a Solid. E. M. Purcell, H. C. Torrey, and R. V. Pound, Radiation Laboratory, M.I.T., Dec. 24, 1945. Phys. Rev. 69:37 (1946).

—United Press photo.

➤ NUCLEAR RESONANCE *based on the magnetic properties of the atom allowed Dr. Edward M. Purcell of Harvard University to determine properties of atomic nuclei by a method similar to that of Dr. Felix Bloch of Stanford. The two scientists share the 1952 Nobel prize in Physics.*

➤ IN THE well-known magnetic resonance method for the determination of nuclear magnetic moments by molecular beams,[1] transitions are induced between energy levels which correspond to different orientations of the nuclear spin in a strong, constant, applied magnetic field. We have observed the absorption of radiofrequency energy, due to such transitions, in a *solid* material (paraffin) containing protons. In this case there are two levels, the separation of which corresponds to a frequency, ν, near 30 megacycles/sec., at the magnetic field strength, H, used in our experiment, according to the relation $h\nu = 2\mu H$. Although the difference in population of the two levels is very slight at room temperature ($h\nu/kT \sim 10^{-5}$), the number of nuclei taking part is so large that a measurable effect is to be expected providing thermal equilibrium can be established. If one assumes that the only local fields of importance are caused by the moments of neighboring nuclei, one can show that the imaginary part of the magnetic permeability, at resonance, should be of the order $h\nu/kT$. The absence from this expression of the nuclear moment and the internuclear distance is explained by the fact that the influence of these factors upon absorption cross section per nu-

cleus and density of nuclei is just cancelled by their influence on the width of the observed resonance.

A crucial question concerns the time required for the establishment of thermal equilibrium between spins and lattice. A difference in the populations of the two levels is a prerequisite for the observed absorption and stimulated emission. Moreover, unless the relaxation time is very short, the absorption of energy from the radiofrequency field will equalize the population of the levels, more or less rapidly, depending on the strength of this r-f field. In the expectation of a long relaxation time (several hours), we chose to use so weak an oscillating field that the absorption would persist for hours regardless of the relaxation time, once thermal equilibrium had been established.

A resonant cavity was made in the form of a short section of coaxial line loaded heavily by the capacity of an end plate. It was adjusted to resonate at about 30 mc/sec. Input and output coupling loops were provided. The inductive part of the cavity was filled with 850 cm^3 of paraffin, which remained at room temperature throughout the experiment. The resonator was placed in the gap of the large cosmic-ray magnet in the Research Laboratory of Physics, at Harvard. Radiofrequency power was introduced into the cavity at a level of about 10^{-11} watts. The radiofrequency magnetic field in the cavity was everywhere perpendicular to the steady field. The cavity output was balanced in phase and amplitude against another portion of the signal generator output. Any residual signal, after amplification and detection, was indicated by a microammeter.

With the r-f circuit balanced the strong magnetic field was slowly varied. An extremely sharp resonance absorption was observed. At the peak of the absorption the deflection of the output meter was roughly 20 times the magnitude of fluctuations due to noise, frequency, instability, etc. The absorption reduced the cavity output by 0.4 percent, and as the loaded Q of the cavity was 670, the imaginary part of the permeability of paraffin, at resonance, was about 3.10^{-6}, as predicted.

Resonance occurred at a field of 7100 oersteds, and a frequency of 29.8 mc/sec., according to our rather rough calibration. We did not attempt a precise calibration of the field and frequency, and the value of the proton magnetic moment inferred from the above numbers, 2.75 nuclear magnetons, agrees satisfactorily with the accepted value, 2.7896, established by the molecular beam method.

The full width of the resonance, at half value, is about 10 oersteds, which may be caused in part by inhomogeneities in the magnetic field which were known to be of this order. The width due to local fields from neighboring nuclei had been estimated at about 4 oersteds.

The relaxation time was apparently shorter than the time ($\sim$ one minute) required to bring the field up to the resonance value. The types of spin-lattice coupling suggested by I. Waller[2] fail by a factor of several hundred to account for a time so short.

The method can be refined in both sensitivity and precision. In particular, it appears feasible to increase the sensitivity by a factor of several hundred through a change in detection tech-

nique. The method seems applicable to the precise measurement of magnetic moments (strictly, gyromagnetic ratios) of most moderately abundant nuclei. It provides a way to investigate the interesting question of spin-lattice coupling. Incidentally, as the apparatus required is rather simple, the method should be useful for standardization of magnetic fields. An extension of the method in which the r-f field has a rotating component should make possible the determination of the sign of the moment.

The effect here described was sought previously by Gorter and Broer, whose experiments are described in a paper[3] which came to our attention during the course of this work. Actually, they looked for dispersion, rather than absorption, in LiCl and KF. Their negative result is perhaps to be attributed to one of the following circumstances: (a) the applied oscillating field may have been so strong, and the relaxation time so long, that thermal equilibrium was destroyed before the effect could be observed—(b) at the low temperatures required to make the change in permeability easily detectable by their procedure, the relaxation time may have been so long that thermal equilibrium was never established.

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[1] Rabi, Zacharias, Millman and Kusch, Phys. Rev. 53:318 (1938).
[2] I. Waller, Zeits. f. Physik, 79:370 (1932).
[3] Gorter and Broer, Physica, 9:591 (1942).

Measuring Magnetic Moment

A New Method of Measuring Nuclear Magnetic Moment. I. I. Rabi, J. R. Zacharias, S. Millman, P. Kusch, Columbia University, Jan. 31, 1938. In Phys. Rev. 53:318 (1938).

➤ It is the purpose of this note to describe an experiment in which nuclear magnetic moment is measured very directly. The method is capable of very high precision and extension to a large number and variety of nuclei.

Consider a beam of molecules, such as LiCl, traversing a magnetic field which is sufficiently strong to decouple completely the nuclear spins from one another and from the molecular rotation. If a small oscillating magnetic field is applied at right angles to a much larger constant field, a re-orientation of the nuclear spin and magnetic moment with respect to the constant field will occur when the frequency of the oscillating field is close to the Larmor frequency of precession of the particular angular momentum vector in question. This precession frequency is given by

$$\nu = \mu H / hi = g(i)\mu_0 H / h \quad (1)$$

To apply these ideas a beam of molecules in a $^1\Sigma$ state (no electronic moment) is spread by an inhomogeneous magnetic field and refocused onto a detector by a subsequent field, somewhat as in the experiment of Kellogg, Rabi and Zacharias.[1] As in that experiment the re-orienting field is placed in the region between the two magnets. The homogeneous field is produced by an electromagnet capable of supplying uniform fields up to 6000 gauss in a gap 6 mm wide and 5 cm

long. In the gap is placed a loop of wire in the form of a hairpin (with its axis parallel to the direction of the beam) which is connected to a source of current at radiofrequency to produce the oscillating field at right angles to the steady field. If a reorientation of a spin occurs in this field, the subsequent conditions in the second deflecting field are no longer correct for refocusing, and the intensity at the detector goes down. The experimental procedure is to vary the homogeneous field for some given value of the frequency of the oscillating field until the resonance is observed by a drop in intensity at the detector and a subsequent recovery when the resonance value is passed.

The reorientation process is more accurately described as one in which transitions occur between the various magnetic levels given by the quantum number m_i of the particular angular momentum vector in question. An exact solution for the transition probability was given by Rabi[2,3] for the case where the variable field rotates rather than oscillates. However, it is more convenient experimentally to use an oscillating field, in which case the transition probability is approximately the same for *weak* oscillating fields *near* the resonance frequency, except that θ is replaced by $\theta/2$ in Eq. (13). With this replacement and with passage to the limit of weak oscillating fields, the formula becomes for the case of $i = \frac{1}{2}$:

$$P\left(\tfrac{1}{2},-\tfrac{1}{2}\right) = \frac{\theta^2}{(1+q)^2 + q\,\theta^2}$$

$$Sin^2\left\{\pi t r\,[(1-q)^2 + q\theta^2]^{\frac{1}{2}}\right\} \quad (2)$$

where θ is $\frac{1}{2}$ the ratio of the oscillating field to the steady field, q is the ratio of the Larmor frequency of Eq. (1) to the frequency r of the oscillating field. The denominator of the expression is the familiar resonance denominator. The formula is generalized to any spin i by formula (17).[2]

In the theory of this experiment, t, in Eq. (2), is replaced by L/v, where L is the length of the oscillating region of the field, and v is the molecular velocity. $P(\frac{1}{2}, -\frac{1}{2})$ must then be averaged over the Maxwellian distribution of velocities. However, the first term is not affected by the velocity distribution if t is long enough for many oscillations to take place. The average value of the $\sin^2$ term over the velocity distribution is approximately $\frac{1}{2}$.

To produce deflections of the weakly magnetic molecules sufficient to make the apparatus sensitive to this effect, the beam is made 245 cm. long; the first deflecting field is 52 cm. in length and the second 100 cm.

We have tried this experiment with LiCl and observed the resonance peaks of Li and Cl. The effects are very striking and the resonances sharp. A full account of this experiment, together with the values of the nuclear moments, will be published when the homogeneous field is recalibrated.

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[1] Phys. Rev. 50:472 (1936).

[2] Rabi, Phys. Rev. 51:652 (1937).

[3] C. J. Gorter, Physica 9:995 (1936).

We are very much indebted to Dr. Gorter who, when visiting our laboratory in September 1937, drew our attention to his stimulating experiments in which he attempted to measure nuclear moments by observing the rise in temperature of solids placed in a constant magnetic field on which an oscillating field was superimposed. Dr. F. Bloch has independently worked out similar ideas but for another purpose (unpublished).

The Story of Antibiotics

by Selman A. Waksman

The following is an extract from a talk given by Dr. Waksman to the Science Talent Search finalists at the Science Talent Institute, in Washington in 1946. It is reprinted from Chemistry *for April, 1946.*

➤ My story of antibiotics can well be begun with a story of the microbes, those tiny, microscopic forms of life that are found everywhere around us, namely, in the soil and in the sea, as well as in other water basins, in our clothing, in the air that we breathe, and on as well as in our own bodies. These lowly living systems, or as they are usually called, microbes, are divided into several groups on the basis of their size, structure, and mode of nutrition, into the bacteria, molds or fungi, algae, and microscopic animal forms such as protozoa and worms. They can also be divided on the basis of their relationship to man, into saprophytic and parasitic or pathogenic forms, or into useful and harmful organisms. It is practically synonymous to designate them as our friends or our enemies.

Friendly Microbes

The useful or the friendly microbes are largely found in the soil and in the sea, in river and in lake waters and in sewage disposal systems. They destroy the residues of plant and animal life, and liberate back into circulation the essential chemical elements necessary for plant growth. They also participate in a number of other processes highly essential for plant and animal life, as in the fixation of atmospheric nitrogen, whereby the inert nitrogen gas of the atmosphere above us is transformed into a combined form, when it can be utilized for fresh plant life. Since animals depend upon plants for their sustenance, it is transformed also into animal forms of life.

Man has succeeded in domestication of many of the useful microbes to serve him in his needs and in his struggle to survive. He utilizes the activities of these microbes in the preparation of his foodstuffs, as in the baking of bread, ripening of cheese, flavoring of butter and production of certain vitamins; in the fermentation of his beverages, as in the making of wine, beer and distilled liquors; in the production of a variety of industrially important chemical compounds, such as alcohols (ethyl, butyl), organic acids (acetic, lactic, citric, gluconic), acetone, glycerol; as well as in various other processes that serve to make man's life on this planet more secure, more rich and more pleasant.

Enemy Microbes

The harmful or injurious microbes, on the other hand, include those that destroy our crops, spoil our foodstuffs, attack our textiles and our habitations, and cause a great variety of other forms of damage to man's economy; also those that attack our own bodies and the bodies of our domesticated and wild animals. These pathogenic microbes cause a variety of diseases and are responsible for the numerous infections and epidemics that have befallen mankind since times immemorial. Some of these diseases are acute, such as pneumonia, typhoid, dysen-

tery, diphtheria, cholera, plague, typhus and the numerous colds, whereas other diseases are chronic in nature, such as undulant fever and tuberculosis; there are many gradations between. These infectious diseases are caused by bacteria, fungi, protozoa, viruses, and various other microbes.

One may now inquire into the possible interrelations between microbes, and especially the effects of the saprophytic forms, upon one pathogen. This question has aroused the curiosity of the scientific investigator since the early days of microbiology. As soon as it became recognized that most of the human and animal infections are caused by bacteria and other microbes that infect the body, multiply there, and bring about the disease, the bacteriologist began to inquire, what becomes of the many millions of microbes that each sufferer secretes daily. This was not merely idle curiosity.

The physician and the sanitarian and public health officers have learned what a heavy price society has to pay when such excreted microbes are not disposed of properly. This was known to have been the cause of the numerous epidemics that ravaged mankind since the dawn of history. Some of these epidemics, namely bubonic plague and cholera, scarlet fever and diphtheria, typhus and influenza, have often resulted in the decimation of a large portion of the population, ranging from that of a small community to that of a whole continent.

It was known, for example, that a single typhoid carrier can bring an epidemic of typhoid to a whole community, by infecting its milk supply, or its bread or confectionery supply. Many an epidemic has been traced to improper sewage disposal or to an unsanitary water condition. Since all human and animal excreta find their way, sooner or later, into the soil, it was no wonder that the early bacteriologists looked into the soil and asked a very pertinent question: What becomes of all the pathogenic bacteria?

The soil was carefully examined bacteriologically and, after detailed studies, the conclusion was reached that, with very few exceptions, bacteria responsible for the numerous infections and epidemics do not survive long there. If a typhoid patient was allowed to urinate on fresh soil, the bacteria were dead even before the excess moisture had evaporated. Similar observations were made for the survival and destruction of the diphtheria organism, the cholera bacteria, and a number of others. It was reported, for example, that the organism causing malta fever, a close relative to that which is responsible for undulant fever in man and for infectious abortion in cattle, survived 69 days in dry sterile soil and 80 days on dry cloth but only 20 days in unsterile manured soil.

These findings were important in establishing the fact that the soil need not be feared as a possible source of epidemics or infections, with only very few exceptions, such as tetanus, antrax, and gas gangrene. But even more important, however, was the gradual recognition of the fact that pathogenic microbes disappear in the soil not because they are unable to survive there but largely due to the presence of certain agents that are responsible for their destruction.

This was substantiated by the following two observations: (1) when a

soil is sterilized, many of the disease-producing bacteria are not only able to survive there but many actually multiply. (2) Repeated additions of certain bacteria to a given soil may result in their accelerated destruction. Other observations as well led to the conclusion that the presence of saprophytic microbes in a mixed microbiological population modify considerably the activities of the disease-producing organisms or may even be responsible for their destruction.

Saprophytic Microbes

The above facts could lead to only one conclusion, namely, that certain of the friendly soil microbes are responsible for the destruction of the disease-producing forms brought into the soil. Once this fact became established, the question was logically raised whether some of the friendly or saprophytic microbes can actually be utilized for the purpose of combatting human infections.

An answer to that question was given in a prophetic vein by Louis Pasteur, the leading pioneer in microbiology and the greatest bacteriologist that ever lived. When he observed that a culture of anthrax bacillus that he used to inoculate sheep did not develop the disease when it became contaminated with another organism, he stated that the ability of certain "common bacteria" to prevent the development of an important disease such as anthrax may lead to great developments in therapeutics.

Unfortunately, the progress made in the utilization of saprophytic microbes for the purpose of controlling diseases and infections caused by pathogenic ones was at first very slow. This was due primarily to the fact that the manner of destruction of the pathogen by the saprophyte was only little understood. Living microbes could not be used for injecting into the animal body, since they would not develop there or might even cause undesirable symptoms. The application of the newly discovered principle of therapy had to wait, therefore, until the active principles or the chemical agent, produced by the saprophytes and capable of destroying the pathogens, could be isolated from the culture of the antagonistic microbe.

These principles or agents have been recently designated as antibiotics, because of their specific effects upon living systems. Suitable organisms had to be selected, proper conditions for their cultivation and large scale growth had to be developed, and chemical methods found for the isolation of the active agents. Not until then could the new science of antibiotics take its place among the other sciences, bordering on the fields of microbiology and chemistry, with applications in medicine and to veterinary science.

Antibiotics

What is an antibiotic? An antibiotic is a chemical substance produced by microorganisms and by certain higher forms of life, which has the property of inhibiting the growth of and even of killing bacteria and other microbes. Antibiotics are characterized by certain properties which distinguish them from the common antiseptics and disinfectants. These properties can be briefly summarized as follows:

Antibiotics are selective in their action upon bacteria, some bacteria being sensitive and others resistant. Each antibiotic is characterized by a specific bacteriostat or antibacterial spectrum,

namely its selective action upon a variety of different bacteria.

Antibiotics differ greatly in their chemical nature. Some are nitrogen free, others contain nitrogen, and still others contain both nitrogen and sulfur. Some are lipoid-like materials, others are characterized by their ring structure; some are polypeptides, and some are basic compounds containing a carbohydrate group.

Antibiotics differ greatly in their toxicity to animals. Some are nontoxic, some are highly toxic and most fall between these two extremes. They also vary in their effect upon animal tissues and body fluids, some being hemolytic and others not.

Antibiotics vary greatly not only in their *in vitro*, but also in their *in vivo* activities. Some are equally effective *in vitro* and *in vivo*. Others are not active at all in the animal body, or their activity is greatly reduced by the body constituents.

Because of their selective activities, some antibiotics injected into the body tissues exert a marked effect upon the bacteria, without affecting the tissues themselves.

Antibiotics vary in their mode of action upon bacteria, the difference being frequently more a matter of degree than of kind. They interfere with certain mechanisms involved in the nutrition and multiplication or growth of the bacterial cell. It is of special importance to note the fact that different strains of the same organisms may vary greatly in the sensitivity to a given antibiotic. Various bacteria have the capacity of adjusting themselves to withstand increasing concentrations of the antibiotic. This phenomenon is of great importance in chemotherapy where the same material may have to be used for a prolonged period of time.

Antibiotics vary greatly in their physical and chemical properties, namely solubility, some being soluble in water and others only in organic solvents, such as alcohol, ether and acetone.

Antibiotics vary in their chemotherapeutic potentialities. Some are highly effective in parenteral or internal administration, whereas others can be used only topically or for surface application. It can readily be recognized from these characterizations that only very few antibiotics have so far found practical application in disease control.

Antibiotics are produced by a large number of fungi, actinomycetes and bacteria. Microorganisms capable of producing antibiotics are frequently spoken of as antagonistic forms. Various methods have been developed for the isolation from natural substrates, such as soils, manures and even dust, of antagonistic microorganisms, in pure culture and for testing their antibacterial potency. Frequently the soil enrichment method is used previous to the isolation of the organisms. This method is based upon the fact that repeated additions of living suspensions of bacteria to a soil may favor the development of microbes capable of destroying such bacteria. More recently, it has been shown that this procedure is of questionable value in the isolation of suitable antagonistic microorganisms.

Antagonistic Properties

The simplest method of testing organisms for their antagonistic or antimicrobial properties consists in streaking the culture of the organism on a

suitable agar medium in a Petri plate, allowing it to incubate for 24 to 48 hours, then streaking toward it several test bacteria or fungi. The width of the zone of inhibition of the various test organisms will not only be a measure of the ability of a given culture to produce antibiotics, but will also serve as a measure of the selective antimicrobial action of such antibiotics.

Once a culture of an antagonist has been selected either because of its potency or because of its selective antibacterial activity, suitable media and proper methods of culture are developed for its growth and the production of the given antibiotic. The maximum activity is usually produced in 2 to 5 days in deep or submerged culture in tanks, and in 7 to 14 days in stationary culture in flasks or bottles.

The antibiotic is usually found in the liquid medium from which it is isolated by means of suitable chemical procedures. Some of the common methods consist in adsorbing the active substance on charcoal, then removing the adsorbing agent by an acid or an alkaline solution or by means of an organic solvent. The antibiotic may also be directly extracted from the medium by certain organic solvents, such as ether, acetone, or chloroform. Further concentration and purification is carried out by suitable chemical procedures.

The antibiotic thus isolated is first tested for its antibacterial properties *in vitro*, in order to determine whether one is still dealing with the same type of substance that was originally present in the culture, since frequently some organisms produce more than one antibiotic. Next, experimental animals are used for determining its toxicity and *in vivo* activity. After such exhaustive tests have been made one can attempt to try the newly isolated agent in the treatment of human infections.

Tropical Woods Immune to Ship Worms

➤ THREE TROPICAL woods immune to the ravages of ship worms have been found by William Ward of the Duke University Marine Laboratory at Beaufort, N. C.

Ship worms ruin dock pilings and small boats by boring into the wood. Although wood may be chemically treated to prevent such attacks, the process is expensive.

Of eight Cuban woods Mr. Ward tested for their resistance to ship worms by suspending in water, one was damaged heavily, four showed slight damage and three were not attacked at all. Their resistance, Mr. Ward says, may be due to wood resins that poison the worms.

The ship worm attacks by latching on to submerged wood with its tail, eating its way inward as it grows. The "undersea termites" reach a length of around seven inches in the Beaufort area, but they have been reported as long as four feet in some tropical waters.

More than 3,000 different sulfonamides have been prepared but only a dozen have been accepted for medical use.

Radiations From Outer Space Detected Best in Upper Air

Cosmic Rays Challenge Researchers

➤ ONE OF THE deepest mysteries of the sky about us is the nature and origin of cosmic rays. What they are, where they come from and what they do currently is puzzling scientists.

Cosmic rays are particles that are accelerated in space to velocities near the speed of light. They include positrons, mesons, protons and heavy nuclei.

Positrons are positively charged electrons. Mesons are particles with a mass greater than electrons but less than the positively charged nuclear proton. Heavy nuclei are atoms that have been stripped of their outer electrons.

The cosmic particles bombard the earth constantly at energies millions of times greater than scientists can obtain with modern cyclotrons. It is not known how they are accelerated to those energies.

Most of the rays that shoot in from outer space do not penetrate the earth's atmosphere to sea level. Called primary radiation, the rays frequently strike atoms of gases that make up the air. When they strike the atoms, usually the atom is smashed and its particles race off in many directions. Those particles are detected on the earth as "secondary cosmic rays."

Scientists studying cosmic rays under a broad Navy program say it is a frustrating task. To study the primary rays, the "laboratory" should be about 23 miles above the earth where the original particles can be found.

Laboratory instruments and equipment, of course, can be carried to such heights by present-day rockets, but the rocket flight is a short-time proposition. Cosmic ray apparatus should be kept at the high altitudes for hours.

Balloons currently are being used by the Navy scientists to carry instruments high into the air and to hold them there while the mysterious particles shoot into the equipment and leave tell-tale tracks on photographic plates. Other equipment radios information to the ground as soon as a cosmic ray is detected.

So tiny are the photographic traces of cosmic rays, they must be found under a microscope. Two dozen plates of film, properly exposed, are sufficient to keep scientists busy for two or three years.

Although they bombard the earth's atmosphere with tremendous punch, comparatively few primary rays penetrate to sea level. Most strike atoms of oxygen, nitrogen, and other atmospheric components. The atoms so hit are ionized and become "secondary cosmic rays." Those are the ones most frequently encountered on the earth's surface.

Most of the secondary rays seem to be born about 110,000 feet high. To get at the original rays, the photographic plates, cameras and Geiger counters have to be carried even higher.

How British Scientists Planned Test Explosion

Britain's A Bomb Aids Civil Defense

Radio talk given in London November 7, by Sir William Penney, who was in charge of Britain's recent atom-bomb explosion at the Monte Bello Islands off Australia.

➤ WHEN the planning began, a lot of thought was given to deciding which type of explosion would provide information and experience of the greatest value. Purely scientific measurements are most easily made when the weapon is placed at the top of a high tower, but there were other weighty considerations. The Civil Defense authorities in this country badly needed more data about atomic explosions and accordingly the test was planned to get as much novel information as possible for Civil Defense. The decision was made to explode the weapon in a ship moored near land, thus simulating an explosion in a port. The ship was to be equipped as a scientific transmitting station, sending out by radio a vast number of measurements about the nuclear explosion before the equipment was destroyed. More scientific apparatus was to be placed on the islands to record other phenomena such as blast, heat and radioactivity.

The question of where to do the trial presented quite a problem. Suitable sites for this sort of work are not easy to find. The Admiralty made a search through their charts and it seemed as if the Monte Bello Islands would offer everything that we wanted. The Australian Government readily agreed to a survey being made of these islands and it was found that they were entirely suitable. The Australian Government, at this stage, generously gave us permission to hold the trial there. They also offered us substantial assistance in preparing the site and in supplying us with food, water and everything else which we needed, in order to work and live in security at Monte Bello.

At a very early stage it was decided to conduct the trial as a military operation and, in May of last year, Admiral Torlesse was appointed to work with me and prepare a detailed plan on the good principle that 'he who plans an expedition should also carry it out.'

An elaborate trial, like the one at Monte Bello, is not completed without some anxious moments. Fortunately there were not many of them, but the night before D-1 Day was, perhaps, our worst spell. In order to get the right winds at the time of the explosion we had to choose a period of of strong winds for both D-1 Day and for D-Day. We got the strong winds all right! The winds were so strong that we were not sure that the boats could get the scientists all round the islands to make the final adjustments of their instruments. However, as always, the Navy and the Marines rose to the occasion and the work was completed with nothing worse than a lot of wet shirts. Even up to an hour before the explosion, we were still anxiously watching the winds to see if the

forecasts of the weather boys were going to prove accurate. In fact, their predictions were absolutely right, and with much relief, the firing clock was started.

I was on the flight deck of *Campania* with Admiral Torlesse and most of the ship's company. We all faced away from the explosion as the last few seconds were counted over the loudspeakers. Suddenly there was an intense flash, visible all round the horizon. We turned to look. The sight before our eyes was terrifying — a great, grayish black cloud being hurled thousands of feet into the air and increasing in size with astonishing rapidity. A great sandstorm suddenly sprang up over the islands. It seemed ages before we heard the bang but, in fact, it was only a minute.

Somewhat to our surprise, a second bang — at least as loud as the first — followed a few seconds later. At the same time we felt a peculiar sensation in our ears such as one has in an aircraft losing height rapidly. We were feeling the suction, or reduced pressure, which always follows a blast wave. All the time the cloud was getting higher and higher and assuming fantastic shapes as it was pulled about by the strong winds at different altitudes.

The explanation of the two bangs heard on the ships and also heard on the mainland is actually quite simple. The first bang was the direct sound wave, and the second was a reflection from a layer of warm air some two miles up.

Many comments have been made about the shape of the cloud and how different it was from the mushroom cloud with the very high stalk shown in most American pictures of atomic explosions. The great weight of the mud and water in the cloud at Monte Bello kept the cloud from rising very far. Even so, the top of the cloud at Monte Bello rose just over two miles above the sea. The explosion had some resemblance to that of the atomic weapon exploded by the United States in the waters of the Bikini Lagoon. The cloud there rose to a height of a little over a mile.

The peculiar Z-shape of the cloud ten minutes or so after the explosion was due to the strong winds blowing in quite different directions at different heights. The cloud was pulled into a gigantic spiral shape which, when seen from the ships and from the mainland, appeared rather like a letter 'Z,' rapidly moving northwards away from the islands and from the mainland.

The experiment went according to plan and the scientific records were complete. We know what happened and we can give to the Civil Defense authorities some accurate answers to some of their problems.

It is, of course, an easy matter to report that we obtained a complete set of records: it is more difficult to convey the scale of the effort involved. Electronic gadgets were the basis of nearly all measurements. We took no less than 300 different types of electronic devices, and many of them were used in half dozens or dozens. Some of them looked like television sets, but instead of a viewer watching a picture on a screen, a camera was used to photograph the record which appeared. In other cases, measurements were automatically passed by radio to a central recording office in one of the ships.

Lots of photographs of the explosion were taken—both stills and moving. Most of the cameras were of types that can be bought in the shops or from scientific instrument makers. However, we were very keen on getting ultra-rapid photographs of the very early stages, when the fire-ball began to burst through the ship. No camera can be bought with the speed that we wanted and so we designed and built our own. We ran our camera in such a way that it took about a hundred pictures at intervals of ten microseconds — that's to say, at the rate of 100,000 pictures per second. The exposure time for each picture was one-ten-millionth of a second!

We expected that the contamination on the land near the explosion would be severe, and one of our primary jobs was to measure the degree of contamination. Naturally, we were not going to take risks by entering the area too soon. The re-entry survey parties all wore protective clothing covering them from head to foot, and they also wore gas masks. The appearance of men in this clothing, scrambling about on the white sand-hills in the blazing sun and peering at their instruments every few seconds was a weird sight. Everyone in the parties sweated profusely and one man lost no less than 17 lbs. in a single trip. However, on return to the health control center, a few long drinks of water, some salt tablets and a meal with lots of tea, quickly restored the loss of weight and nobody felt any the worse.

An aspect of the trial which calls for comment is the harmonious way in which scientists and service men have worked together in a combined amphibious operation. The fighting services nowadays often comment on how technical all their paraphernalia is becoming. On this occasion they not only had to put up with loads of scientific apparatus but they also had the scientists as well. The ordeal was not as bad as they feared and everybody learned valuable lessons.

Chemical Production in Alberta

➤ THE REMARKABLE growth of Texas during the past decade or so in the production of chemicals may be matched in the near future by Alberta province, Canada. Its vast and newly discovered oil and natural gas fields can supply the same raw materials on which much of the chemical industries of Texas depend.

Although Alberta oil reserves were discovered only about six years ago, the province now has many hundreds of producing wells and a pipeline for crude oil stretching over a thousand miles to the Lake Superior area. Chemical companies have already moved into the production area. Heavy production of petroleum chemicals is promised.

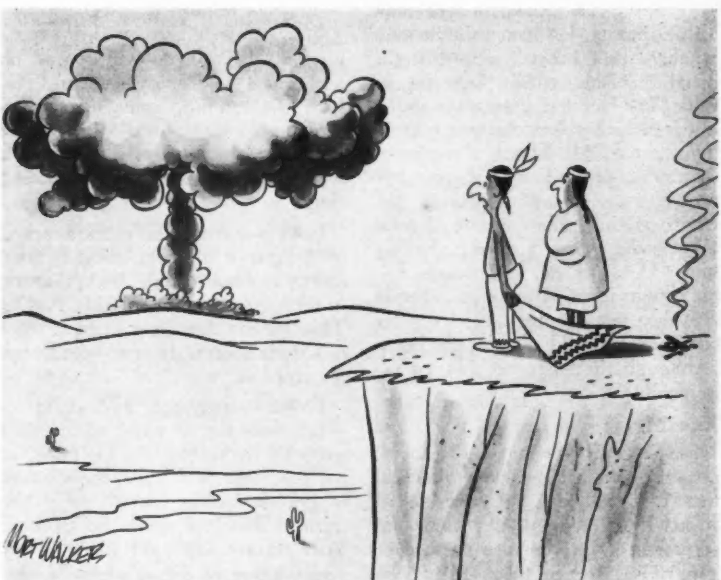
One of the most recent plants to be put in operation was installed by the Shell Oil Company and is for the recovery of sulfur from natural gas. This gas, from wells in the Jumping Pound field, contains a considerable amount of hydrogen sulfide from which a high-grade sulfur is obtained. Capacity of the plant is about 30 tons of sulfur a day, an amount that will help considerably in the present sulfur shortage.

The great oil fields of Alberta are

a score of miles or more south of Edmonton. To the north of this modern city are great deposits of bituminous sands, the Athabaska tar sands. Crude oil and other petroleum products can be obtained from them, although a commercial process for their extraction has not yet been developed.

When petroleum from other sources becomes limited, these Athabaska sands, together with bituminous sands in the United States, may play a big part in providing fuel oil, gasoline, chemicals and other bituminous products for the North American continent.

Alberta has deposits of several minerals that may make it a chemical producing region. But perhaps of more importance, Edmonton is the gateway to the north to areas in which lead, zinc and nickel have been found. This northern country is also Canada's hopeful uranium country. Geiger counters have picked up radioactivity in a region stretching from Lake Athabaska, in Alberta and Saskatchewan, north to Port Radium on Great Bear Lake. It is near Lake Athabaska, Sask., where the "boom town" Uranium City is developing as the center of uranium prospecting.



➤ "WHOEVER *it is, he sure uses big words.*"

For the Home Lab

Gold!

by BURTON L. HAWK

➤ PERHAPS no other metal has played such an important part in the destiny of man as has gold. For centuries it has stood as a barometer of wealth and nobility. To secure it, men have fought, suffered and died. Countries have been founded through the search for it; kingdoms have been lost because of it.

Why?

Well, we can supply three reasons. Value. Beauty. Permanence. Obviously, there is a limited supply of the metal available which increases its value. The fact that it is usually found free in nature makes it easy to mine—if you can find it. That it is attractive, we cannot deny. There are very few people who do not appreciate the warm, shining yellow beauty of gold. (We would greatly appreciate having some). And, finally, its appearance is quite permanent. Aluminum becomes dull, iron rusts, copper corrodes, silver tarnishes, but gold remains the same. (Although, it must be dusted occasionally).

The Metal

Despite our glowing words above, metallic gold has very few practical uses. It is really a metal to be looked at, not to be used. About its only use at present is in the manufacture of jewelry. And even then it must be alloyed with other metals, usually copper or silver, as it is too soft to be used in the pure state.

In jewelry, the purity of gold is expressed in carats. A carat indicates the number of parts of gold in 24 parts of metal. For example, a 14-carat piece would be 14/24 gold and 10/24 other metals. Expressed in percentages, it would be 58-1/3% gold and 41-2/3% other metal. An 18-carat piece would contain 75% gold (18/24). The gold currency formerly used in the United States was 90% gold, or 21.6 carats. And, of course, any 24-carat piece would be solid gold.

Now, how much of this experimenting you can do will depend on how much gold you can secure. Perhaps you can find some bits of discarded gold jewelry around the house —maybe an earring, or a link from a watch band, or a few unused wedding rings.

Gold is inactive and is not attacked by oxygen or ordinary acids. It does, however, react readily with chlorine to form gold (auric) chloride, $AuCl_3$. Thus we can dissolve it in aqua regia or chlorine water, both of which supply chlorine.

Prepare aqua regia by mixing together one part of nitric acid with 3 parts of hydrochloric acid. Drop in the gold piece and warm the solution to get the action started. After the metal is dissolved, filter the solution. Your filtrate will most likely be an acid solution of the chlorides of copper and gold. If there was any silver in your metal, it will have been filtered off, as silver is not readily attacked

by chlorine and even if it is, the resultant silver chloride is insoluble in water.

To obtain a neutral solution of the mixed chlorides, evaporate the filtrate to dryness and dissolve the solid thus obtained in water. The gold may be separated from this solution by adding a solution of ferrous sulfate, which reduces the gold chloride to metallic gold but does not affect the copper chloride. The reduction is accomplished as follows: $AuCl_3 + 3FeSO_4 \rightarrow Au + Fe_2(SO_4)_3 + FeCl_3$. The precipitated gold is usually brown or black. Filter off the precipitate, scrape into an evaporating dish and heat to obtain the ordinary yellow color. Gold melts at 1063 degrees. If you want to try to melt the finely divided powder into a coherent mass, you might try using a blowpipe.

The Compounds

To obtain a relatively pure solution of gold chloride, dissolve some of the pure metal obtained above in aqua regia. Evaporate to dryness to secure the dark orange-red crystals. Finally, dissolve these crystals in distilled water.

Add a solution of stannous chloride to a dilute solution of auric chloride, just prepared. The "Purple of Cassius" precipitate will be formed. This is a delicate test for gold. So, if any of your friends want to make certain that an item of their jewelry actually contains gold, you can confirm it simply by dissolving the jewelry in aqua regia and applying the above test.

Another test is the orange precipitate formed by adding potassium thiocyanate to gold chloride and gently warming.

If auric chloride crystals are heated gently, aurous chloride, $AuCl$, is obtained. When this powder is heated strongly, metallic gold remains and chlorine is evolved.

Oxalic acid will reduce gold chloride solution to metallic gold. The solution must be neutral and the action is hastened by the presence of ammonium oxalate. The metal separates in metallic flakes or will form a golden mirror on the side of the tube: $2AuCl_3 + 3H_2C_2O_4 \rightarrow 2Au + 6CO_2 + 6HCl$.

When sodium hydroxide solution is added in excess to auric chloride, sodium aurate, $NaAuO_2$, is obtained.

Magnesium hydroxide added to auric chloride will form the orange hydroxide, $Au(OH)_3$. This can be filtered, dried, and carefully heated to 100 degrees to obtain auric oxide, Au_2O_3, a brown powder. Further heating will give the purple aurous oxide, Au_2O. Still further heating will result in metallic gold and oxygen is evolved.

Rather unusual reactions are obtained with potassium iodide. Add potassium iodide solution to auric chloride in small portions, keeping the *latter* always in excess. A yellow precipitate of aurous iodide, AuI, is formed, soluble in excess of the iodide. But if you reverse the procedure by adding the auric chloride to the potassium iodide and keeping the *iodide* in excess, a dark green solution of potassium-auric-iodide, $KIAuI_3$, forms followed by a dark green precipitate of auric iodide, AuI_3, which is unstable and changes to the yellow aurous iodide.

Well, at this point the experiment

is becoming too expensive for us, so we must stop.

At least there is one consolation. You can save all of your solutions and change all compounds back to metallic gold simply by applying strong heat. Thus all of the gold you have used can be recovered again. (It says here).

Gold Film De-Ices Windshield Electrically

➤AIRCRAFT WINDSHIELDS and windows can be de-iced without difficulty or electrical risk using an electrically heated glass coated with a thin film of gold.

Developed at Britain's National Physical Laboratory, the glass is more transparent and has less electrical resistance than previous experimental products using a current-carrying layer of gold on the glass.

The gold is deposited on the glass to a thickness of about one quarter of a millionth of an inch by a special, easy-to-handle process. Current flowing through the gold film generates enough heat to melt ice that forms on the glass.

Nickel, Penny, Moist Paper Battery

➤ A NICKEL, a penny and a piece of moist paper make a tiny but effective battery, an engineer from Minneapolis-Honeywell Regulator Co. has found.

While out in the field, he had to make a quick test of an amplifier, but lacked the usual test equipment. Applying some high school physics, he inserted a one-inch square of moist paper between a copper penny and a nickel five-cent piece. The difference in the electrical properties of the two metals set up a tiny electrical current. The current was enough to cause a balancing motor to move in opposite directions when the position of the amplifier's lead wires on the two coins were reversed. His six-cent battery thus proved that the amplifier was in operating condition.

Fluorescent Tagging of Air

➤A PARTICULAR parcel of air, as it moves through the atmosphere, will scatter and diffuse into an area 1,000,000 times its original size before it has gone 10 miles. This takes place in as short a time as two hours.

Three scientists at the New Mexico Institute of Mining and Technology "tagged" air with minute fluorescent pigments and then followed with airplanes their travels through the skies.

With this new technique the scientists were able to trace the diffusion of the air for more than 100 miles, about four times as far as it had ever been done before. The scientists are Drs. Roscoe R. Braham, Ben K. Seely and W. D. Crozier.

Tagging air is useful in measuring diffusion of our atmosphere due to turbulence. Out of such work may come knowledge useful in industry in preventing air pollution with factory smoke and other exhausts. Weather men want to know how air moves about and is diffused so they can make better forecasts.

Scientific Discovery
Like Artist's Creation

The Nature of Scientific Research

Abstract of a paper delivered by Dr. David Meredith Seares Watson, Professor, Harvard College and University College, London, at the Autumn meeting of the American Philosophical Society in Philadelphia.

➤ PERSONAL experience is the only way to learn the nature of scientific research. The possibility of doing such work depends on storing up in an individual mind facts or more usually generalizations from which many facts may be inferred, in such a way that they are constantly going in and out of consciousness.

A scientific problem is usually recognized from the handling of material or from recorded data and, if it seizes the imagination of a scientific man, comes repeatedly into his consciousness.

Here it is brought into association with other "facts," in varying assortments, until, often suddenly, an explanation of the problem presents itself. This explanation may provide a new point of departure, a key to other problems, and its own truth may so gain further confirmation. The process goes on until the worker loses interest in the matter because it has ceased to provide him with new paths of study. But it may be revivified by new material, or by the development by other people of ideas which impinge upon it.

Thus an original stock of facts recorded in memory leads to the making of generalizations, which in turn may solve other problems and in so doing be further verified.

The process of scientific discovery is intensely personal; everything has to come together in a single mind. Probably only in the case of two men of equal ability, closely associated, is genuinely joint work possible.

But it seems that this process of scientific work does not differ from that employed in the fine arts.

The immense series of drawings made by Albert Durer and Leonardo da Vinci which survive, show that they were men of vast curiosity, constantly learning new facts and automatically recording them in drawings.

The scheme of a picture seems to have presented itself suddenly in outline, and there are drawings, scribbles, made in a minute or two by Leonardo and by Michaelangelo which are perhaps the first idea of works, a Leda and the Medici tombs, which were carried further in scores of drawings, perhaps even to completion in a modified form.

The elaboration of the details of these works involved detailed studies of figures, plants, ornament, a process entirely parallel to the elaboration of an initial solution of a scientific problem.

That they are indeed similar is shown because both possess style. The work of a scientific man is as clearly his, as is the work of an artist.

But in the days of Durer and Leonardo, works of art were made usually for a patron who set out his requirements in detail; they were examples of applied art. But in some cases they are masterpieces still satisfying, which altered the course of artistic development from the time of their making.

Thus we may be encouraged to believe that applied scientific work may make as great contribution to the common stock of knowledge and understanding as avowedly "pure research." But it will do so only if it gives to individual men the opportunity to follow their own fancy wherever it leads.

Super-Low Temperatures Explored

➤ THE strange world of super-low temperatures is being explored in Duke University's new low-temperature laboratory.

The key instrument in the new program is a \$24,000 helium liquifier capable of cooling helium and other gases down to temperatures as low as 455 degrees below zero Fahrenheit.

The low-temperature study at Duke is aimed at seeking explanations of the strange properties of helium, and certain metals, when they are cooled to super-low temperatures.

Helium, cooled to 445.5 degrees below zero Fahrenheit, will not "stick together" it will crawl up and down the sides of containers in search of heat. It can also apparently transfer heat without any loss due to friction.

In addition, some 20 metals act in strange ways when they are cooled to low-temperatures. Some become superconductors and can carry current, seemingly indefinitely, without loss.

The new Duke laboratory is seeking to find out more about this new world of physics, and experiments are following this three-point program:

1. Studies of superfluid helium, including a study of the difference in properties of two helium isotopes, helium three and helium four.

2. Investigations of super conductivity.

3. Work in the field of micro-wave and radiofrequency spectroscopy.

Director of the laboratory is Dr. William M. Fairbank, newly-appointed associate professor of physics at Duke. Theoretical consultant to the laboratory is Dr. Fritz London, internationally-known expert in this field, whose theories in low-temperature behavior represent pioneer work in this area of research. Dr. Walter M. Nielsen is chairman of the Department of Physics.

Unbalanced Equations

Will o' the Wisp?

➤ Now the company will sink a borehole at Eskdale in the North, riding in search of methane.

—*Chemical and Engineering News.*

Mounting Cost of Fuel Helps Develop Insulating Materials

Fuel Costs Can Be Cut

by A. C. Monahan

➤ Increasing costs of all types of fuels for house-heating are perhaps responsible for increased activities during the past few years to develop construction methods and insulating materials to hold the cost of heating within reasonable limits. Considerable success is reported.

Among the "new" in heat conservation is a dwelling in Cincinnati in which all rooms are lined with aluminum foil. A tile made of glass and resin is available for inside walls and ceilings. A fiber-glass matting between the outside brick in the sidewall and the tile blocks behind it assures a construction through which little heat can escape. Then there is a new type of wallboard, made of the abundant marsh reed, which is low in cost, weather resistant and an excellent insulator. The newest development is based on the use of tiny glass spheres for the aggregate in concrete or in plaster.

These are but a few of the heat-saving construction methods and materials that have been developed. Several methods of heating have been developed which may result in less cost for winter comfort. Included is the heat-pump which brings into the house heat from the soil below the frostline. Again, progress is reported in heating homes with solar energy, captured direct from the bright rays of the sun during daylight, even in winter months, and stored in the building for use as needed. Many heat-pumps are now in successful use throughout the world, and solar heating is found partly successful even in cold New England.

The difficulty involved with the use of heat-pumps is the cost of the electricity needed to operate the system. Where electricity is cheap, however, it is economical. It has been described as an electric refrigerator working in reverse. It pumps highly compressed freon or other heat pick-up material through long pipes buried in the outside soil. Even the small amount of heat in the earth warms the refrigerant, partly converting it into a gaseous form. It is this latent heat, causing gasification, that is delivered into the rooms of the house to provide a comfortable living temperature.

Solar Heat

In southern regions, solar heat is used directly in house-warming. Large glass windows occupy the southern exposure of the building. An overhanging porch roof, properly placed and of the proper slope, shades the windows during summer months when the sun is high in the sky, but permits the heat rays of the sun to enter the building when the sun is low during the winter.

This type of solar heating is not satisfactory in northern climates where colder weather is found. There some type of storage for the heat gathered

in the day must be provided for use in the evenings and during the night. The most common storage material used is water. It is in storage tanks behind a southern roof made largely of glass. The heated water circulates through coils in the rooms of the house when heat is needed.

Glauber's Salt

Many other materials have been used for solar-heat storage. One of the most successful, in an experimental sun-heated house in Dover, Mass., is Glauber's salt in sealed cans. This well-known inexpensive chemical, technically sodium sulfate, liquefies at high summer temperatures and solidifies again when it loses heat. In the process of converting from a solid to a liquid it absorbs much heat, what is known as latent heat or the heat of liquefaction. Its presence is not evident by a change in temperature. It is the heat required for conversion, and is similar to the heat absorbed when ice turns into water.

The aluminum-lined dwelling in Cincinnati is the home of Dr. Clarence A. Mills of the University of Cincinnati. Its sidewalls and ceilings are lined throughout with heat-reflecting aluminum foil. Aluminum foil is used in the floor construction. It is said to keep the house warm in winter and cool in summer without conventional heating or air-conditioning. Troughs along the tops of the walls contain electric heating elements for winter and cooling coils for summer. The reflective aluminum keeps heat from escaping and also directs it back to the persons in the room.

A "marsh-reed" ranch-type house, constructed recently in Virginia, employs for sidewalls, roof and floors a "thatchboard" developed in the Netherlands. But America has plenty of this marsh reed, very little of which is now used for any purpose. A "thatchboard" industry is expected to develop soon in this country. It holds a promise of a wallboard for both inside and outside uses that is durable, economical, resistant to the elements, decay, fungus and insects, and also is an excellent insulating material.

The Virginia thatchboard house uses frame construction with the board made from marsh reeds on inside and outside. The subfloor and the roof also utilize the same material. The roof is covered with asphalt shingles, nailed directly to the thatchboard. The outside walls are stuccoed, and inside walls are plastered, but both could have been left without this additional finish.

Glass Spheres

The tiny glass spheres for use instead of other aggregate in wall plaster, plaster wallboard and concrete, result from very recent developments by the Armour Research Foundation of the Illinois Institute of Technology and will soon be available on the market as Kanamite, a product of the Kanium Corporation of Chicago.

The spheres, about the size of grains of sand, are made in a tall vertical furnace where fine particles of clay are dropped through a very hot curtain of gas-air flame in which they form. They contribute light weight and strength to concrete and plaster in which they are used in place of the customary sand. From the heating standpoint, they form a construction material which has high resistance to the passage of heat.

These are but a few of the newer

developments in building construction whose primary purpose is to save the cost of heating. Some can be used only in new construction but old houses can be lined with aluminum foil or fiber-glass tile. Their installation would save heat but there are many steps to prevent heat-escape in houses that should be taken before expensive wall linings are installed. Little was done in many houses to prevent "heat-escapes" in days when the fuel bill was a minor item.

Storm windows for winter use on all windows of the house, and particularly for those of the north and west in areas where the prevailing winds are from these directions, are of special importance. Properly installed storm windows can cut heat losses by 25%, engineers estimate as the result of experimental work. Any householder can determine that storm windows are helpful merely by touching a window pane with his hand. Without the outside protection the inside of the pane is cold to the touch. With it, the inside of the pane is approximately at room temperature.

How Heat Escapes

In many of the houses built a few years ago, and even in some of today, there are invisible cracks and crevices through which heat can escape. They can be determined on a cold windy day by the coldness in their neighborhood. The remedy is simple. It means stuffing the cracks with rags or some of the commercial materials developed for this purpose. A favorite place for these "air-leaks" is around window and door frames, under the eaves in the attic at the top of the sidewalls, and in the cellar along the sills of the building.

Lining the attic is also important in the prevention of heat losses. The heated air in a building naturally rises to ceilings and into the attic if possible. Tight attic flooring will prevent much of the escape to the upper space of the house but it is even more important to prevent heat-escape through the roof itself. For this reason the underside of roof rafters should be covered with material that resists the passage of heat. Heat losses through the roof are shown by the length of time snow after a storm remains on it. Snow melts slowly if the roof is properly insulated.

Furnace Inspection

Regardless of how well the building is constructed, economical heating requires proper furnaces, in good condition and properly operated. The fall of the year is the proper time to have the heating plants inspected, adjusted, and repaired if repairs are needed. For the millions of American homes equipped with gas or oil furnaces, the job is for the expert. The cost is usually over-balanced by the fuel saved. Coal-burning furnaces can usually be put in condition by the householder himself.

The first step to be taken in the inspection of the coal furnace is an examination of all dampers and checks to see that they are neither broken nor warped. If they are, replacement is the remedy. Stove pipes should be examined because they burn thin with constant use and are then a fire hazard. The most important job is cleaning the flues and combustion chamber of the furnace. Wire brushes, manufactured for the purpose, and the expenditure of sufficient muscular effort, do

the job, but it needs re-doing several times during the heating season.

The layers of soot that collect on the inside of a furnace are carbon and excellent insulators. They prevent the passage of the heat generated into the air, water or steam box surrounding the flues. The heat instead goes up the chimney to heat the great outdoors. Proper firing of the furnace will help to prevent the soot accumulation. It will also prevent the direct loss of heat that goes up the chimney in smoke.

A smoky chimney is usually a sign of improper firing. Smoke comes from incomplete combustion. It is particularly important that the users of bituminous coal know how to prevent the formation of smoke. Proper distribution of fresh coal on the burning material in the firebox is essential. Plenty of air to provide oxygen for combustion is equally essential.

In the ordinary home furnace, where coal is applied at the top of the burning fuel, the fresh bituminous coal should be heaped in a conical pile near the center, or in sloping piles around the sides. Combustion takes place at the lower edges of the pile and it is far more apt to be complete, and smokeless, than when the coal is spread over the entire burning surface.

If the draft on the furnace does not permit the entrance of sufficient air for complete combustion, a blower can be used. A small-size electric fan may do the job. The use of such an artificial draft in the home follows a practice in giant furnaces used in industrial plants which employ jets of air. These discharge air under pressure through jets into the fire, particularly as fresh fuel is being applied. Such jets were used during the recent war in the boilers of ocean vessels. They prevented the belching of smoke from the stacks of the vessels, a telltale of their positions to enemy vessels.

Electron Microscope Work Speeded

➤ MUCH VALUABLE research time is expected to be saved by two electron microscope devices developed by Francis W. Bishop of the University of California's Atomic Energy Project at Los Angeles.

One is a device which monitors the stability of the power supply that feeds the electronic lenses. The slightest fluctuation in current often markedly affects the quality of photographs taken through the microscope. The new monitoring device gives advance warning of instability in the power supply, allowing the operator to make adjustments before damage is done. A "magic eye," suited to the darkness in which electron microscopists work, blinks advance warning of trouble to come.

The second is a diaphragm adjuster which functions similarly to that of a camera. It permits the viewer to select and center any one of five apertures, through which images are brought into sharper focus, by a simple external adjustment. Formerly each of the apertures, which range from .001 to .005 of an inch in diameter, had to be inserted and centered by a complicated, manual trial and error method.

Chemists Take Syrup Apart
To Understand Its Flavor

That Maple Flavor Is Complex

➤ WHAT MAKES maple syrup taste like maple syrup, instead of something else, strawberry jam for example? The solution of this seemingly simple problem may mean better maple flavor for syrup, sugar and ice cream.

Dr. William L. Porter, analytical chemist of the Eastern Regional Research Laboratory, Philadelphia, told the American Chemical Society's Summer Analytical Symposium at Michigan State College that maple sap from the tree has absolutely no maple flavor. The smoky maple flavor is developed during the process of converting the sap into syrup in huge open kettles over a roaring wood fire. This process is related to the browning operation that changes the color of over-ripe fruit.

Any substantial improvement in maple flavor will require a complete understanding of the source, properties and method of formation of this flavor. This is a chemical process, and to understand it a complete chemical analysis of the sap that goes in and the syrup that comes out will be needed.

This understanding is what government chemists are seeking in their efforts to preserve the maple industry, one of the oldest industries in the United States, a farming enterprise which makes the only product that must be processed by the farmer before it can be sold.

In their investigations into the composition of maple flavor Dr. Porter and his colleague, Dr. Charles O. Willits, divided both sap and syrup into three components, acidic, neutral, and alkaline, by a special process developed in previous research on the browning of apricots. Individual components, present in minute quantities, have been separated by chromatographic techniques (adsorption on paper or other chemical adsorbents) and identified by analysis.

The acidic portion has been shown to be a mixture of twelve acids, four of which have been identified so far (fumaric, succinic, malic, and citric).

Two different kinds of sugar, invert sugar and sucrose, have been identified among the carbohydrates of the neutral portion. Alcohols and other classes of compounds are also being separated out for study.

The alkaline portion has been shown to consist of compounds of amino acids, the building blocks of protein.

Chemical Marketing and Economics

➤ A DIVISION of chemical marketing and economics has been created by the American Chemical Society, for members interested in this aspect of research and development.

Frederic A. Soderberg of the General Dyestuff Corporation was elected first chairman of the division.

An Account of the Influence of Sugar on Modern Candies

From Honey to Sugar

Reprinted from
"The Sugar Molecule," Sugar Research Foundation, Inc., New York, N. Y.

➤ MANY OF the earliest sweets and some of our most popular candies today owe their origin to their medicinal or nutritive value. Pharmacists first made them in small batches and sold them in their little shops because they were good for the buyer as well as having been quite often 'nice.' Even as far back as the second century of our era, Galen, the Pergamenian physician, was prescribing the juice of the sugar cane as a tonic, which it certainly *is,* because of its contained sugar in its natural liquid form it is especially stimulating as a quick energy food. Much more nourishing, of course, is sugar in its solid state, whether as a household sweetener or in candy.

Pharmacists among the early candymakers progressed in their art as refined sugar became more freely available and replaced honey which, at one time, was the only sweetener. They have been responsible for medicated lozenges and pastilles, malt-sugar confections, colt's-foot rock, soothing gum drops (made from the gum of the Acacia tree and not from starch), rock candy or sugar candy, 'dragées' and 'comfits,' cough-drops, licorice in its several forms, compressed tablets (peppermint, with or without alkali), lemon drops, barley sugar, honey drops, and marshmallow or *guimauve*, which is still made occasionally and ethically in Europe with the gummy extract of the plant marshmallow.

The fluffy, spongy candy known as marshmallow so popular today is clearly misnamed since it contains *no* natural marshmallow, but is commonly made from sugar, with glucose and gelatine replacing the honey and the glutinous marshmallow-extract that was found to be efficacious for sore throats. The real marshmallow is usually a small white cube, tough in consistency.

It would be possible to multiply examples of the ancestors of our modern candies which have reached us through the pharmacist, but it is worthwhile to call attention to the great change in candy types that took place as soon as refined sugar, instead of honey, became available as a relatively cheap sweetener. The early pharmacists were first to take advantage of sugar in making candies, and sugar is responsible for the progress and remarkable growth of the independent confectionery industry as we know it today.

Until the 15th century of our era, when refined cane sugar became a commercial if still limited commodity, honey was the only sweetener for candy-makers outside India. The honey-sweetened halvas, nougats, and Turkish pastes, for example, the consistency of which was soft and very sticky until the use of sugar stiffened them up, have been known for untold centuries in the Near and Middle East of Europe and Africa.

It may come as a surprise to some to learn that the sugar cane (*Saccharum officinarum*), indigenous in Asia between Cochin and Bengal, was introduced into the Americas about 1510 by the Portuguese and Spaniards after they had failed to cultivate in Italy the cane that they had brought from India.* Many earlier attempts had been made to grow sugar cane on a commercial scale without success in Tripoli and Syria from where it was brought, in 1138, to Madeira and Sicily with equally disappointing results. Today, the American continent and the neighboring islands of the West Indies provide a very large percentage of cane sugar for their own use and for world consumption.

Beet Sugar is New

Sugar from the beet is, of course, a comparative newcomer, having been encouraged only in 1800 by Napoleon Bonaparte who, blockaded by the British Navy in his conquered Europe, quickly saw the value of sugar and the importance of the work of M. Achard who had produced excellent sugar in small quantities from locally-grown beets in 1799.

The honey situation in the Americas is a little vague prior to 1670 when it is recorded† that "bees were introduced into Boston and have since spread over the continent." That statement referred, of course, to the *cultivation* of bees for their honey, since honey, as such, was used in Mexico to sweeten the age-old beverage, chocolate ('chocolatl'), long before it was mentioned by the Conquistadores under Cortez in 1521 as Montezuma's favorite. Honey bees of some sort, therefore, thrived on the continent centuries before the white occupation. Incidentally, our modern solid sweet tablet chocolate and coatings could not exist today without sugar, and were unknown in the "honey era."

When and how the corn sweeteners came into existence is a long and ancient story.

Japanese Amé

The Japanese have a sweet product called *amé,* made from rice starch and malted wheat, which was said to have been invented at the urging of their first divine Emperor in some far-distant mythical past when searching for a perfect food for his subjects. He quite obviously slipped up in *not* producing the still more nutritious sugar during his reign.

Amé (a thick, very viscous mixture of dextrose, dextrins, some maltose, and water, and more 'gooey' in consistency than ordinary corn sirup) is still offered for sale by peddlers in the streets of Japan. They dip into the gummy mass a thin stick of wood and draw out, by a twisting motion, a glob of sticky sweetness. Apart from being the earliest record known to us of a starch sweetener, its form as sold to the Japanese children also antedates the sugar apple and later lollypop of the Western World as a "candy on a stick."

Like *amé*, the corn sirups are, of course, starch-converted products, but there are several candies that make use of gelatinized starch which roughly replaces the dextrins of the corn sweeteners. Of this type of confection, only one need be mentioned since it is basically the forerunner of others

* See De Candolle in "Origin of Plants."
† Haydn's Dictionary of Dates, 4th Ed., 1873.

that have been markedly changed for the better since the introduction of refined sugar.

Rahat lakoum ('Turkish delight' or 'Turkish paste') is one of the oldest of candies and is still made in the Near East of Europe from the starch of the *kukurutz* (corn or maize) and honey with sufficient water to gelatinize completely the starch granules. These ingredients are boiled together for many hours, with constant stirring and occasional additions of water, until a slap of the hand on the surface of the boiling batch without sticking indicates that the paste has been cooked long enough to set sufficiently when cooled. It is in this way that the original *rahat lakoum* was made. The introduction of refined sugar as an ingredient replacing a considerable proportion of the honey both speeds up the preparation and provides a firmer, less sticky candy. Today, sugar is almost universally used in the West with corn syrup instead of honey in making Turkish pastes.

Turkish paste is basically the forerunner of the modern gum drop. Unlike *rahat lakoum,* which should be matured until "short" before being considered fit to eat, the gum drop owes its popularity to its toughness, achieved by higher cooking and by the substitution of sugar and corn syrup for honey. Even the modern *rahat lakoum* and the gum drop, however, are inclined to "sweat," for which reason the former is well dusted with starch and powdered sugar (originally only starch), and the latter "sanded" with fine crystal sugar to overcome the stickiness and tendency to "sweat."

It will be readily appreciated that the making of candy in Europe long preceded the first voyage of Columbus to the New World, in 1492, which was soon followed by the introduction of sugar cane to the American continent and neighboring Indies in 1497-8. It is, therefore, to Europe that we look for the early progress in the confectionery industry through the use of sugar, even if American confectioners have since caught up with, and sometimes surpassed, the European. In looking backwards, we should not fail to consider the homemade candies —the popular toffee, and the much-later fudge, which is possibly an American discovery. Yet it is clear that both these candies owe their existence to sugar and, therefore, cannot date in America much before the 17th century, when European immigrants began to arrive in considerable numbers. It so happens that some of the small towns in the valley of the Rhône in France provide us with excellent examples of the transformation of candies from a honeyed stickiness to the modern drier types resulting from the use of sugar in lieu of the older sweetener. For our purpose, we need mention only three such towns—Apt in Provence, and the near-by Carpentras and Montélimar.

Candied Fruit

Apt (the Apta Julia of the Romans) is situated in the finest fruit-growing district of Provence and supplies the world today with some of the best candied fruits, of which the "Bigarreaux Napoleon" cherry (both candied and canned) is particularly famous. More than one Apt man has immigrated to America to start in the candied fruit business in the New

World, and to pass along his ancestral experience.

We have been able to trace back to 1350 the history of Apt as a town noted for its candied fruits or *fruits confits,* when the records show that the connoisseur, Pope Clement VI, (who reigned in Avignon from 1342 to 1352) was a large and regular buyer of a mixture of all the local fruits of Apt, cooked and conserved in honey and grape juice. It should be noted also that the year 1350 was still well within the honey, pre-sugar era, and that, consequently, the conserves then made were of poor color and of a consistency about that of a whole-fruit jam—or, if the fruits were drained of the sweet liquid, they were sticky in the extreme and unattractive to the eye.

Chinese Ginger

The Chinese still make conserves of ginger and of kumquats in syrup in much the same way, but these confections are clearly not the sort that one would offer to one's best girl to enjoy in a movie. Such an obvious, possibly fatuous, admission does, however, illustrate most strikingly the changes that took place in the fruit-conserves of Apt (as elsewhere) after the introduction of bulk sugar more than two centuries later. Then, the treatment of the fruits in concentrated sugar solutions enabled bright-colored, firmer, more handy, and drier candied fruits to be made, and these could be carried around and enjoyed at any time and in any place. In other words, without sugar, we should be still in the sticky honey era or, possibly, in a starch-sugar age that could scarcely be termed "more enlightened and less sticky."

Today, Apt has a number of up-to-date factories busily employed in making first-class candied fruits (sugar-sanded, crystallized, and plain), much of which are exported. These have entirely displaced the dull-colored, honeyed fruit-conserves upon which it built its reputation of old through a Pope, but which now give gustatory pleasure especially to young ladies of our present generation.

Such was the power of sugar to change and enlarge the scope of one very considerable department of the candy industry!

In all fairness, it should be mentioned that some corn syrup is used today, mostly when conserving the *less acid fruits* in sugar syrup for export. It should also be remarked that while corn syrup gives a sticky if attractive glossiness and prevents drying-out of the fruits on the shelf, it also gives an undesirable toughness to the candies that is not regarded favorably by the connoisseur.

The reason for the emphasis laid on the addition of corn syrups to sugar syrups used to conserve *the less acid fruits* has, in all probability, been already detected by the bright reader, though greater emphasis will be given when dealing with the town of Carpentras and its specialty, the bull's-eye.

Carpentras (Vaucluse), also in the Rhône Valley and another large producer of candied fruits, is the hometown of the *Berlingot,* or bull's-eye, which has been called with some justification "the leading sweet of France." This is a hard candy of a pinkish-gold color with fine white stripes and is variously flavored, but most generally with peppermint. When the originator of this candy first displayed it at the

International Paris Exhibition of 1874, it caused a sensation and was so quickly and widely copied that it became necessary to make a court ruling that "M. Eysséric was the first and only manufacturer who (in 1851), by improving the quality of the sweet, had rendered it popular and unique of its kind."

M. Gustave Eysséric had long been a manufacturer of preserved fruits, and his sugar syrups had acquired a special flavor and some acidity through his particular method of treatment. However, the syrups could not be used indefinitely and, until his first preparation of the *Berlingot*, had usually been added little by little to fresh batches of sugar syrup, or used as the liquid for what we know today as canned fruits. The discovery that a special candy could be made from these syrups revolutionized Eysséric's whole business until, at this time of writing, the *Berlingot de Carpentras* is responsible for an industry in itself and is as well known throughout France and her colonies as the *Nougat de Montélimar*, both endlessly copied.

The *Berlingot* was not, to be sure, the first hard candy, but it so happened that the sugar syrups of Eysséric were slightly acid and some of the sugar had become inverted by the acid of the fruits treated in them. It was, then, only a case of boiling these syrups high enough and, lo, the *Berlingot* was born! Nor was there any need for a sugar substitute such as corn syrup.

The modern confectioner will smile that any such simple discovery should even require recording yet, on second thought, he may realize that, if it had not been for the introduction of sugar as the preserving-agent for fruits, among other confections, even the hundred-year-old bull's-eye, as it is made in Carpentras, would not exist today. The formula has not been changed in Eysséric's up-to-date factory whatever the other several imitative manufacturers of the *Berlingot* in Carpentras may be doing.

On still further consideration it will be realized that, when honey and grape juice were *alone* used for conserving fruits, the liquid syrups *could not possibly* have been boiled to produce the simplest of hard candy, and that such a discovery as that of Eysséric must have been duplicated in many parts of the world following the general use of sugar in the confectionery industry.

First Nougat

Montélimar (Drome) owes its present fame to its nougat, with which it is, indeed, almost synonymous.

Etymologically, "nougat" derives its name from the local dialectal word "*nougou*" or "nut," combined with the general French word "*gâteau*" or "cake." Nougat is, therefore, officially a nut cake!

The first nougat of Montélimar has been described as a jam of filberts preserved in honey. This honey-nut confection was known in Babylon, Athens, and Carthage centuries before it appears in the records of Montelimar. The inclusion of egg-whites seems to have been a later improvement. According to the records of the town of Montelimar, the civic authorities decided to present their already famous "white jam" to Philip V of Anjou and his brothers (a "quintal" each, now about 100 pounds) on the

occasion of a visit in 1701 to their town. This custom was continued for other celebrated visitors, and we learn of 20 pounds being presented to the Persian ambassador in 1714, and an unknown quantity to Louis Philippe of Spain in 1774. In those days, the now famous confection of Montelimar was still a nut jam rather than a nut cake.

Today, Montélimar nougat is, rather, an almond cake owing to the extensive cultivation of the almond tree by Oliver de Serres at the beginning of the 17th century on his vast estates a few kilometers from Montelimar. The refining of cane sugar was begun about the same time in Marseille, and the present-day nougat gained its reputation as it became a more solid type because of the use of refined sugar in its formula.

The 'Nougat of Montelimar,' though endlessly copied throughout the civilized world, remains unique particularly because of the delicious lavender-honey of the district, and the special "know-how" of manufacture which is not as easy as many imitators believe. The modern nougat is, however, still a sticky candy, an objection overcome by both the use of edible rice-paper and individual wrapping, though its world-wide fame, because of its huge exportation, is entirely due to the solidity or body given to the one-time "white jam" by the inclusion of sugar in its make-up.

High-Calory Intravenous Feeding

➤ A STABLE glucose-alcohol solution which will supply more than 1,200 calories per liter when fed intravenously has been developed at the University of California at Los Angeles School of Medicine.

Solutions commonly used in intravenous feeding at the present time furnish only up to 400 calories per liter. This is not adequate to meet energy requirements of patients, much less furnish extra calories needed in the healing processes. The new solution will do both.

Some solutions of high energy content have been developed previously, but all were unstable and could not be kept any length of time. The newly-developed solution can be stored indefinitely.

Developers of the new solution are Dr. John M. Beal, Dr. Frank Spencer and Dr. Jullian Smith of the surgical staff of U.C.L.A. and the Wadsworth Veterans Hospital.

Much of the investigation leading to the development of the solution was done at the Wadsworth Veterans Hospital. The research was supported by gifts from Don Baxter, Inc., and the U. S. Public Health Service.

Fabric used in some army tents is treated with a flame-retarding chemical preparation so that stoves may be used inside the tents with safety.

Much nitrogen for fertilizers is obtained from ammonia which, in turn, can be made from natural gas.

Ship Construction Materials
Must Resist Spread of Fire

No Burning Deck

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➤ THE NEW S.S. *United States* is the last word in fireproofing, the latest step in a long struggle toward safety for passenger ships. While the term "fireproof" is used advisedly — since there is always some degree of flammability present in clothing, bedding, and other articles which cannot be controlled — all the furniture and equipment of the new liner is made of materials which will not support combustion, and the possibility of a serious fire is at a minimum.

Ships have always been more difficult to fireproof than shore installations, because of the weight and space problem. Some progress in controlling shipboard fires had been achieved by 1935, through international agreement on safety in design. The *Morro Castle* fire that year, however, brought to the attention of the shipbuilding industry the necessity for fireproofing interior furnishings and decorations. The report of the investigation of the *Morro Castle* disaster became the foundation for the fire protection standards of this country. Development of new fireproof materials and of flameproof treatments for conventional materials has permitted extensive revisions in these standards, but they still remain the basic criteria for ship construction in the United States.

The Standard Temperature Curve governs selection of shipboard construction materials. The curve describes a situation in which the temperature in a burning room reaches 1550° F. in one hour. For passenger vessels built in the United States, partitions between cabins must be made of incombustible materials which will confine such a fire for 30 minutes, while the walls of major fire control subdivisions of the ship, as well as stairways and control areas, must hold it for an hour. The insulation of the partitions must be adequate to prevent the temperature of the unexposed side from rising more than 250° F. above the original temperature. These provisions are intended to restrict the spread of flames to limited areas where the fire may be fought, without interfering with passenger evacuation. Ships are divided into fire zones, with doors between; these are closed automatically from a master switch in case of fire.

Not all materials commonly thought to be fireproof will meet the requirements of the Standard Temperature Curve. Recent tests showed that aluminum or steel panels and doors, now widely used on ships because of their light weight and fire resistance, will not prevent spreading of fire unless the metal is protected by some type of insulation. Without such protection the metal may melt and set the adjacent cabin on fire. Paint often is a source of fire transmission, and several new finishes have been developed

to resist heat. Many new ships are panelled with a hard-surfaced asbestos board which does not require paint.

In the S.S. *United States*, fire retardant paint, which will not ignite or burn at temperatures above 1500°F., is used throughout. There is no wood in the ship, except for the chopping blocks in the galley, and the pianos. All the furniture is made of aluminum, with glass fiber as filler for the upholstery, and all the fabrics used for draperies, rugs, and so on, are treated to make them flameproof. The only possible source of fire would be in the passengers' belongings, and since the ship's furnishings and structure will not support combustion, the likelihood of an extensive fire is extremely remote.

Rare Earth Metals Make Better Alloys

➤ LITTLE KNOWN metals called "rare earths" may soon be extensively employed in improved alloys because they are becoming more available as by-products of the atomic energy pile, and by new chemical methods of separation.

The biggest potential new market for the rare earths is in steel-making, Dr. Clyde Williams of Battelle Memorial Institute, Columbus, Ohio, recently stated. They may also play important roles with aluminum and magnesium. The rare earths improve resistance of the primary metals to oxidation and corrosion at high temperatures, impart strength, cut down impurities, or make the primary metal easier to work into desirable shapes.

There are 14 rare earth metals in the periodic table of chemical elements but there are four others closely associated with the 14. One of them, thorium, is of special interest to the Atomic Energy Commission because it has possibilities of becoming important as a raw material for atomic energy.

The so-called rare earths are not so rare, but they are little known and little used outside of scientific circles because they are hard to separate from each other and from the ores in which they occur. Cerium is the best known and at present the most widely used. Because it "strikes fire," it is employed as an active ingredient in the so-called flints of cigarette lighters. Of greater importance, however, is its use in an alloy containing magnesium and zirconium used in jet-engine parts.

These rare earth metals as yet have no simple names. The 14 include cerium, promethium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutecium. The associated four are lanthanum, yttrium, scandium and thorium. Some of these names commemorate the places where they were discovered.

Commercial production of the rare earths has been handicapped by the fact that they are much alike chemically. New chemical methods for separating them are promising. In these, the ores are put into solution, and the solutions passed through beds of ion-exchange resins. In the resins, the rare earths are absorbed one by one.

Self-Confidence and a Patent Attorney May Help You Turn Your Idea Into Cash

How to Patent Your Idea

by Allen Long

➤"I have an idea," the letter begins, "but I do not know how to patent or sell it. What do I do?"

Queries such as that pour into the United States Patent Office daily. Thousands of embryo inventors scattered from coast to coast want to convert their ideas into money.

Patent Office officials say hundreds of other persons probably have invented gadgets to use around the house, but have not considered having them patented. Many of those gadgets might be turned into cold cash. Even yours.

Patent procedure is complex. But with a little self-confidence, a good patent attorney, a sum of $300 and a practical, new idea, you can overcome the complexities of the law easily. You do not need a model of your device.

Standing by to give you assistance is the National Inventors Council. The Council will evaluate your idea, so far as it relates to the needs of the armed forces or to the welfare of the nation.

Items the Council deems worthy of further governmental investigation are referred to the Department of Defense or to the appropriate agencies. But whether or not the Council refers your idea, you can call attention to your invention through the Patent Office's "Register of Patents" that circulates to many manufacturers. You also can take your invention directly to the manufacturers.

But before you do that, you should start the wheels turning toward getting a patent for your device. That is true especially if your invention will be manufactured commercially. Few manufacturers will discuss your idea until you at least have filed a patent application.

The companies consider that the wise thing to do. They may be working on a gadget similar to yours. Discussing your idea may result later in a lawsuit if the company puts out a device similar to yours, and you believe they stole some of your ideas. Dates on the patent applications will help clear up the dispute.

It is difficult to say how much a patent will cost. A lot depends upon how long it takes the patent attorney to search files for similar inventions. But for the amateur whose inventions will not be too complex, $300 is an estimated average.

Suppose you invented a dandy dandelion puller this summer to cut down back-breaking toil in your weed-infested lawn. Suppose it has pincer-like jaws operated remotely from the end of a four-foot handle. Suppose also that you want to patent and market it. This is what you do:

Chances are that someone already has invented the same thing. Even so, your device may be sufficiently different from other inventions so that you could patent it. But you need a patent attorney to find out.

If you cannot visit the Commission-

er of Patents yourself, write him for a list of attorneys and agents registered to practice before the U. S. Patent Office. The list costs $1.75.

After you have hired an attorney, you should tell him all about your idea. He will not divulge your secrets since he may be disbarred if he does.

The attorney will search through Patent Office records for similar inventions. He will compare your weed-puller with other weed-pullers.

Depending upon his findings, he will advise you to file a patent application. That will cost $30. You will plunk out another $30 when the patent is granted.

A free booklet available from the Commissioner of Patents called "General Information Concerning Patents" describes the patent application. It also contains other helpful information.

The specifications-and-claims section of the application probably is the most important. It describes what you consider to be your invention.

Since the claims must be carefully worded, it would be wise to let your attorney write them. You sign the document saying you believe yourself to be the first inventor of such a weed-puller.

If the device can be illustrated, drawings should be included in the application. Unless you are skilled in mechanical drawing, you should hire a competent draftsman. But unless specifically called for, no model should be sent to the Patent Office.

Your attorney will handle the rest. It takes about three years for the average patent to go through. If by that time you have found no manufacturer for your device, you can have your patent listed in the "Register of Patents," a list of patents that are for sale.

Thomas' Register of American Patents, available at many libraries and business offices, provides a convenient list of companies who make weed-pullers. Each company is a potential buyer of your idea. Thus under the heading of "Weeders," about 40 companies and their addresses are listed.

You may be unsuccessful in persuading a company to make your device. That is the "calculated risk" you take. But on the other hand, you may be successful. And that extra income should feel mighty fine in your wallet.

Failure More Rewarding Than Success

➤ The scientific investigator, like the pioneer in any field, faces the paradoxical fact that failure may be at times more rewarding than apparent success, according to Edward Mallinckrodt, Jr., chairman of the board of the Mallinckrodt Chemical Works, who received the 1952 Midwest Award of the American Chemical Society's St. Louis Section. The failure of existing theories or concepts to account for experimental results may lead to the discovery of more accurate and complete explanations.

An apparently anomalous or contradictory phenomenon may have more to reveal, could the investigator but comprehend its inner significance, than a seemingly more rational phenomenon.

Inventors Apply Chemicals To Make Living Comfortable

Patents on Chemical Materials

Patents may be ordered by number from the Commissioner of Patents, Washington 25, D.C., at 25 cents a copy. Remittances should be sent in coin, money order, or U.S. Patent Office coupons, not stamps.

Aviator's Oxygen Mask

➤ An oxygen mask for aviators, which automatically increases the amount of oxygen going into the face mask as the altitude of the plane increases, has been invented by Richard E. Stockman, South Euclid, Ohio. He assigned the patent, number 2,608,200, to the U. S. Air Force.

The reduced barometric pressure at high altitudes works on a diaphragm on a chamber in the face mask to allow more oxygen to get to the aviator's lungs.

Insecticide for Crabgrass

➤ An insecticide may be the nemesis of the crabgrass that disfigures so many lawns.

A group of compounds of thiocyano ethers will kill crabgrass without hurting the lawn grass. This method of getting rid of the weed has been patented by Loyd Q. Boyd, Hammond, Ind., and Albert A. Endres, Homewood, Ill. They assigned patent number 2,608,479 to the Standard Oil Company of Indiana.

The inventors say the thiocyano ethers employed as insecticides are limited in number because many members of the class are skin irritants and thus cannot be applied to the bodies of animals. However, this factor is of no importance in their use to get rid of crabgrass.

The aqueous emulsion or hydrocarbon solution form in which the chemical is applied should be used so that the crabgrass is wetted, the inventors say. It shou'd be applied so that about 80 gallons an acre are received, or about one to two gallons of the dithiocyano ethers or esters per acre.

Self-Heating Can

➤ Hot beans or soup at a picnic are the intention of an invention by Ernest H. Stofel, Elmhurst, N. Y. He has assigned his invention, number 2,606,547, to Thermo-Snack, Inc., also of Elmhurst.

Mr. Stofel wraps the can in a casing of combustible material about 1/16th of an inch thick. This is set afire. In about 50 seconds, for a number two can, the food inside is brought to a temperature of about 150 degrees Fahrenheit, the inventor claims.

Harvesting Seaweed

➤ From Scotland come two new tools for harvesting seaweed under water. One was invented by William MacKenzie, Edinburgh, for which he received patent number 2,610,459. The other, patent number 2,610,458, was invented by John Morrison Hay and Robert Faulds McIver, Edinburgh. Both were assigned to Scottish Seaweed Research Association of the same city.

The first consists of a grapnel to engage the seaweed and a skid so it is not caught on the bottom. The grapnel is towed by a boat and lifted from the sea when sufficient seaweed has been collected.

The other has a receptacle for holding the seaweed, an inlet mouth at the front and weed cutting means next to the mouth. Water can escape from the bag but not the seaweed.

Mattress Fireproofing

➤ PERSONS who smoke in bed may do so with greater safety if they have a mattress with a fire-resistant glass fiber layer protecting the flammable portions of the mattress. This is much cheaper than trying to make the whole mattress fire resistant, according to the inventor, Robert J. Taylor, Birmingham, Ala. He received patent number 2,610,338 and assigned it to the Perfection Mattress and Spring Co.

Water-Repellent Windshield

➤ A WATER-REPELLENT windshield surface for use particularly in airplanes has been invented and turned over to the Canadian government. The inventor, Donald F. Stedman, Ottawa, claims that his treatment has many advantages. It gives a very clear vision in rain without using wipers, it has a long life, it can be applied quickly anywhere, it is invisible and free from optical distortion, it stores well and is inexpensive.

The treatment consists of two applications. First is applied an alkyl or aryl substituted poly-silicane. This is mixed with carbon black, or some other adhesion-promoting agent because the poly-silicanes are not of themselves adhesive to glass. Adequately strong friction, provided in the rubbing by the addition of carbon black, will cause adhesion of the poly-silicanes to the glass or plastic windshield.

After this is applied, the carbon black is wiped off. While the surface produced by the silicanes is "distinctly repellent," according to the inventor, this is not good enough for airplane windshields. The water droplets still travel too slowly across the windshield for good vision. Therefore, it is necessary to use a second coating of a non-polar water-repellent wax.

The invention received patent number 2,612,458, and it was assigned to the Honorary Advisory Council for Scientific and Industrial Research, Ottawa.

Chemist Receives 22 Patents Same Day

➤ONE MAN has received 22 patents from the government on the same day. This was an unusually high number, but the Patent Office was unable to determine whether it is a record.

The prolific inventor is Melvin De Groote, University City, Mo., a chemist with the Petrolite Corporation, Ltd., Wilmington, Del. Nineteen of his patents were variations on a process for breaking petroleum emulsions. The other three were also chemical.

Mr. De Groote has received many other patents before, the Patent Office said. Believed to have held the most patents during his lifetime was Thomas A. Edison, with 1093.

Book Condensations

New books in chemistry listed for readers' information. These or any other American books in print may be ordered through Science Service, Book Department, 1719 N St. N.W., Washington 6, D.C.

Send check or money order to cover regular retail price. If price is unknown, send $5.00 and change will be returned. We will pay postage in the United States. For each free publication desired, send 10c to cover handling.

MODERN PLASTICS ENCYCLOPEDIA AND ENGINEER'S HANDBOOK 1952—Hiram McCann, Ed.—*Plastics Catalogue Corporation*, 848 p., illus., $2.00. Technical articles and all sorts of useful information about modern plastics and their manufacturers.

SYSTEMATIC COLLEGE CHEMISTRY—Lytle Raymond Parks and Warren H. Steinbach—*Blakiston*, 692 p., illus., $5.50. A new text for the student who has had a high school course in physical science, whether or not he has previously studied chemistry.

SURFACE COMPLEXES ON CARBON BLACKS. I. High Temperature Evacuation Studies — R. B. Anderson and P. H. Emmett—*Mellon Institute*, 3 p., paper, free upon request to publisher, 4400 Fifth Ave., Pittsburgh 13, Pa.

TWELFTH SEMIANNUAL REPORT OF THE ATOMIC ENERGY COMMISSION—Gordon Dean, Chairman — *Govt. Printing Office*, 125 p., paper, 35 cents. A summary of major advances in atomic energy programs from January to June, 1952, including research in the medical, biological and physical sciences.

A SOURCE BOOK IN CHEMISTRY 1400-1900 — Henry M. Leicester and Herbert S. Klickstein — *McGraw-Hill*, 554 p., illus., $7.50. Original writings of famous chemists from Biringuccio and Agricola to Marie Curie.

TEXTBOOK OF ELECTROCHEMISTRY, Volume I—G. Kortum and J. O'M. Bockris—*Elsevier*, 351 p., $7.00. An English translation of a German text published in 1947. The work has been revised and the bibliography now includes many English language works.

A TEXTBOOK OF QUANTITATIVE ANALYSIS — Andrew Patterson, Jr. and Henry C. Thomas—*Holt*, 500 p., illus., $4.25. Written because of the author's conviction that it is not because of complicated matters that chemistry gives the student trouble but because trouble is anticipated where none, in fact, exists.

THE THEORY OF ISOTOPE SEPARATION AS APPLIED TO THE LARGE-SCALE PRODUCTION OF U235—Karl Cohen—*McGraw-Hill*, 165 p., $2.00. Reports issued by the theoretical division of the SAM laboratories and its antecedents covering work done from 1940 to 1945 plus new material from outside sources.

THE UTILIZATION OF SUGAR CANE BAGASSE FOR PAPER, BOARD, PLASTICS, AND CHEMICALS: An Annotated Bibliography—Clarence J. West—*Sugar Research Foundation*, 2d ed., 202 p., paper, free upon request to publisher, 52 Wall Street, New York 5, N.Y. Bagasse offers one of the great untapped sources of collected raw material from which paper pulp can be made.

Proudly Presented

➤ HEATING TAPES can be used to apply heat to standard or odd-shaped vessels. The flexible tape contains resistance wire covered with white braided Fiberglas yarn. It can be wrapped around small glass vessels of standard or odd shape, especially distilling or fractionating columns. Besides a standard weight, there is a heavy insulated Fiberglas grade and bands insulated with quartz that can be used to put around pipes. The manufacturer is Scientific Glass Apparatus Company, Bloomfield, N. J.

➤ SURFACE treatments applied to metals often involve solutions containing oxidizing agents. Peroxygen compounds, useful for such purpose, include hydrogen peroxide, compounds forming hydrogen peroxide in solution, persulfates and peracids. Their chemical and physical properties are told in bulletins available from the Buffalo Electro-Chemical Co., Buffalo, N. Y.

➤ A LABORATORY planning kit which shows how the things will fit in before the material arrives is issued by Fisher Scientific Co., Pittsburgh 19, Pa. Besides the catalog and photographs showing various laboratory schemes, there are scaled cutouts of furniture and graph paper on which to slide them around until you have the best arrangement.

➤ X-RAY DIFFRACTION and Geiger counter X-ray spectrometric equipment is described in a catalogue issued by the Research and Control Instruments Division, North American Philips Company, Inc., 750 South Fulton Avenue, Mount Vernon, N. Y. The electron microscope is also included.

➤ AS PART of the educational campaign being conducted by the Manufacturing Chemists' Association, a pamphlet, "Chemicals and the Food You Eat," has been issued. One section is devoted to a description of how chemicals for food use are developed.

➤ "FACTS AND FIGURES for the Chemical Process Industries" has appeared in a third edition published by the American Chemical Society's journal, Industrial and Engineering Chemistry. It contains a wide variety of statistical information and interpretive articles on various fields. America's chemical industry has grown at the rate of 10% a year for the past quarter of a century. In 1952 it is having its greatest plant expansion, with a capital outlay of almost $1,500,000,000.

➤ WHAT the Batelle Memorial Institute, Columbus, O., has done in the way of research for the petroleum industry is told in a new publication. Some of the research undertaken is related to the elimination of drilling troubles, developments of by-products, increase of locomotive efficiency, ways to free petroleum products from sulfur, etc.

➤ ACCIDENT PREVENTION, first aid, fire prevention and safety equipment are featured in the new edition of Fisher's Manual of Laboratory Safety. It can be obtained from Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa., or from Fisher Scientific Co., Ltd., 245 Carlaw Ave., Toronto, or 904 St. James St., Montreal.

Colors Separated
By Chromatography

Spots Put to Work

➤ LITTLE SPOTS on a piece of paper enable chemists to identify small quantities of exceedingly complex materials. They often permit scientists to separate chemicals that have been mixed together, and cut them apart with a knife or pair of scissors.

Let a drop of black ink fall on a piece of white absorbent paper and you have a black stain. But if you moisten the paper beforehand, or stick an end into water so it acts as a wick and draws water up through the spot, you will probably get several colored bands. This simple experiment gives you a pretty good idea of how this method of chemical analysis works.

Color is the key-note to the new laboratory technique that is becoming so popular. Its name, paper chromatography, tells you how it works. "Chromatography" is derived from the Greek "chroma" meaning "color," and "graph" meaning "write."

The compounds identify themselves by colored bands or spots. Since one dye is carried by capillary action across the paper faster than another, the colors are soon separated.

The individual dyes making up a green or brown ink may be seen directly when separated. A solution of an invert sugar, like milk sugar, dextrose or honey, however, is just as colorless as a solution of cane or beet sugar. But they can be distinguished by streaking their invisible chromatograms with potassium permanganate.

Often water is used to separate the mixtures, but sometimes water will not produce the desired results. Sometimes it is more satisfactory to use pure methyl or ethyl alcohol, isopropyl alcohol (rubbing alcohol), acetone (sometimes sold to remove fingernail enamel) or petroleum ether (fluid from a cigarette lighter).

The yellows and oranges in paprika, for instance, separate out well with petroleum ether, and the yellows and greens in leaves show up with isopropyl alcohol. But this new analytical technique is still somewhat in the trial-and-error stage with scientists experimenting to discover the best solvent to use with specific chemica's.

Powdered chalk, magnesia, alumina and diatomaceous earth are also good carriers for the chemicals. But paper is so simple and quick to use, it is usually preferred.

Now round up whatever dark inks you may have handy and try each in turn. First thoroughly moisten with water a piece of the paper that works best, then let a drop of washable black ink fall upon it. Does the ink separate into bands of green and red?

Washable ink is usually made black by combining complementary colors. India ink, on the other hand, is made of black carbon similar to the lead in your pencil, and a type of permanent black ink is made of iron tannate, a black compound.

After you have tried inks, experiment with vegetable dyes and water infusions of bright colored flowers.